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AVIATION AND AERONAUTICAL ENGINEERING

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VOLUME V
Number 9

SPECIAL FEATURES

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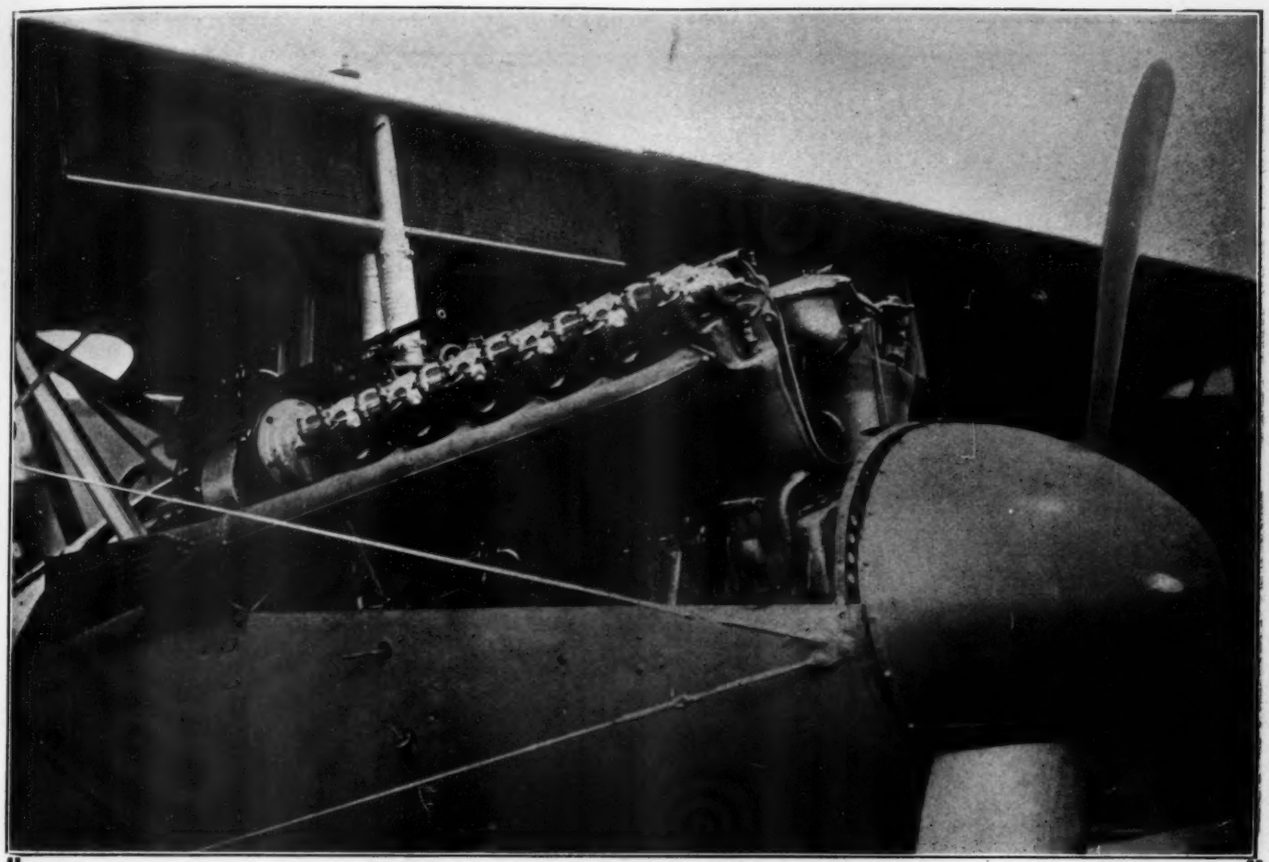

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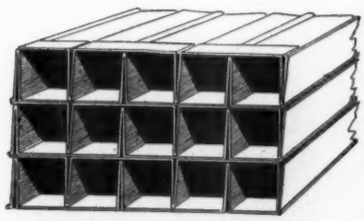

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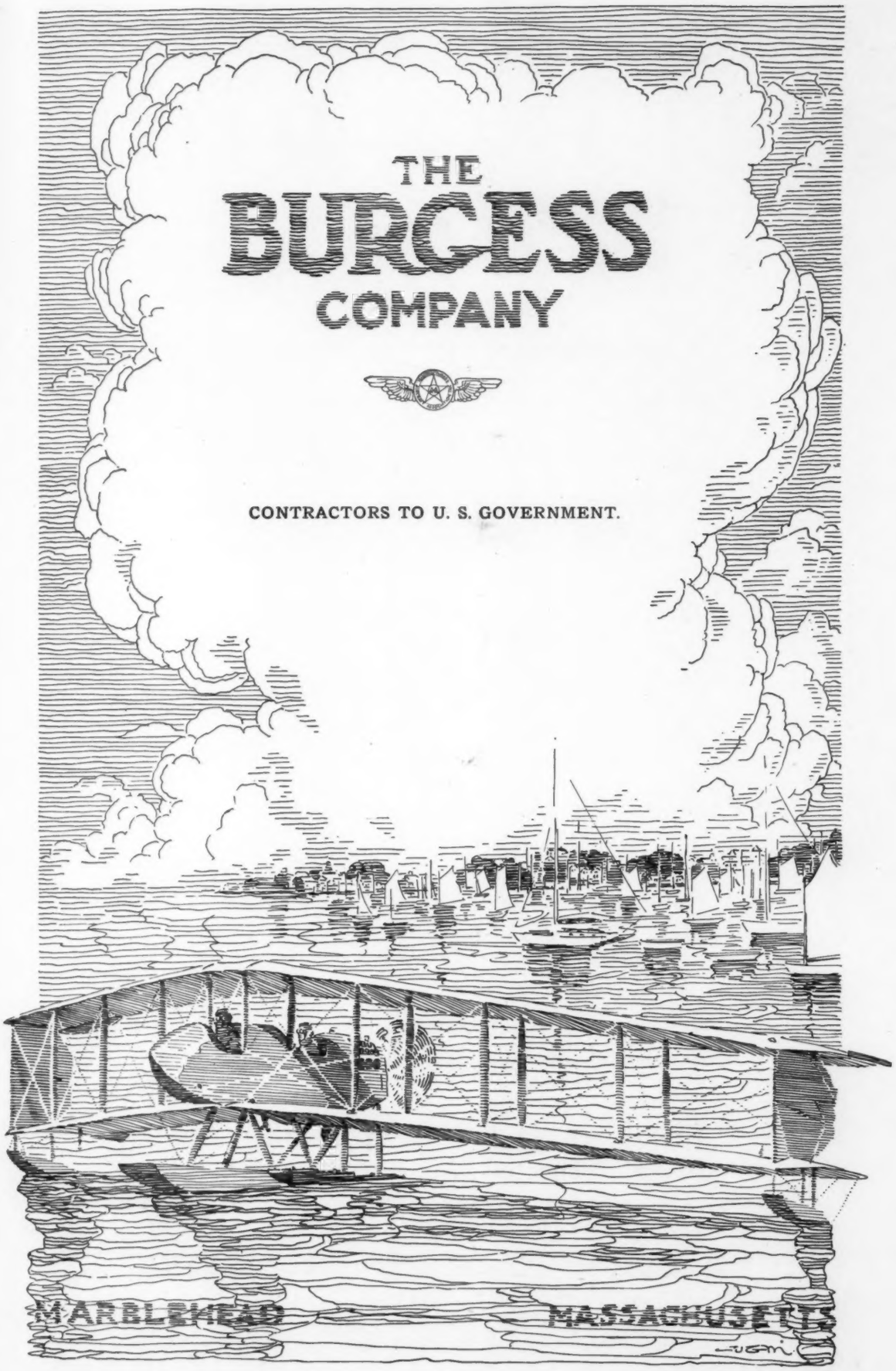
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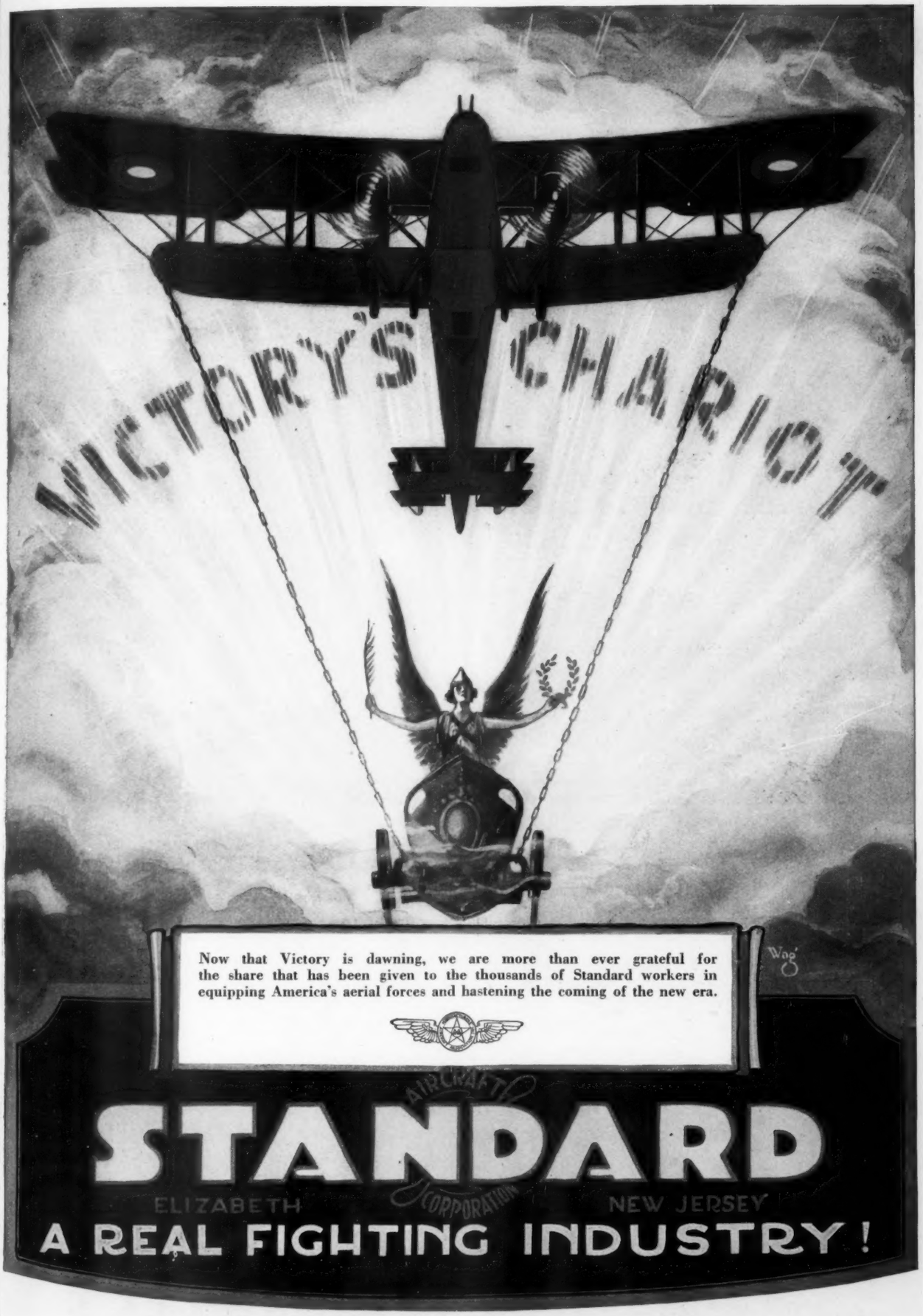
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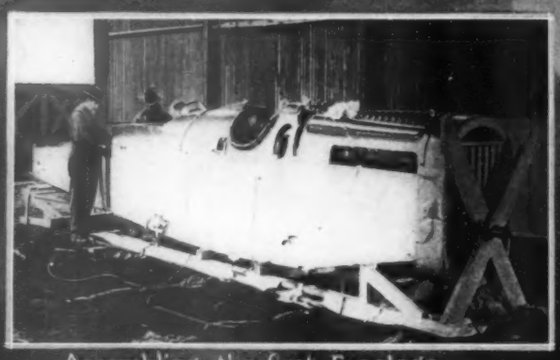
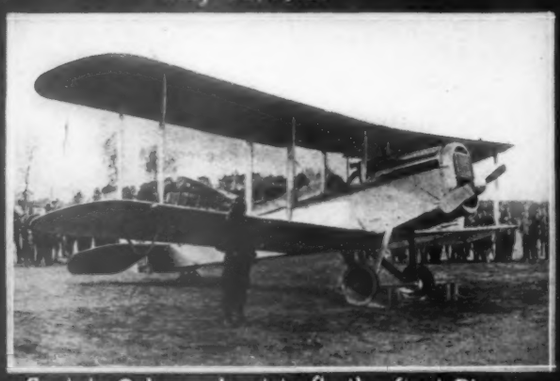


Assembling the first Fuselage May 16, 1918.

Above train load of our Planes, after unloading in France.



Captain Osborn about to fly the first Plane May 17, 1918.

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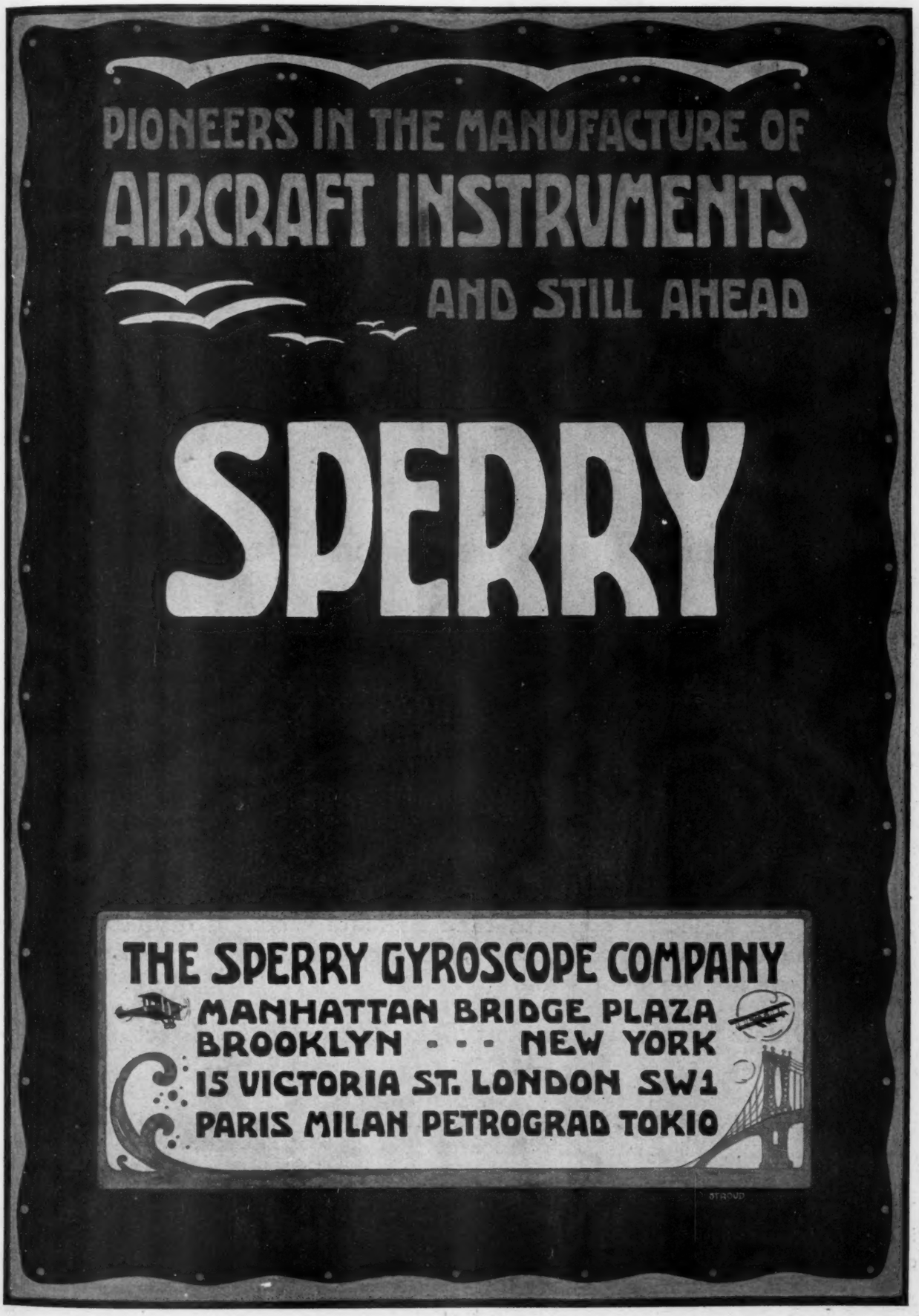
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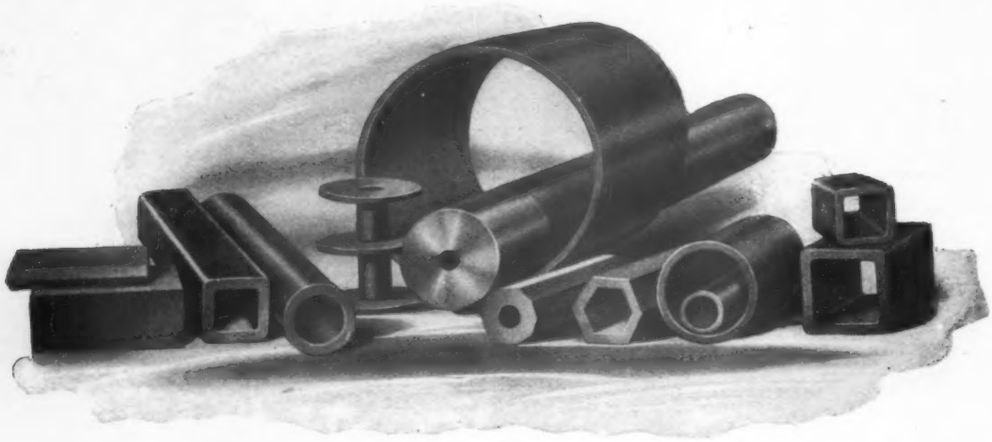

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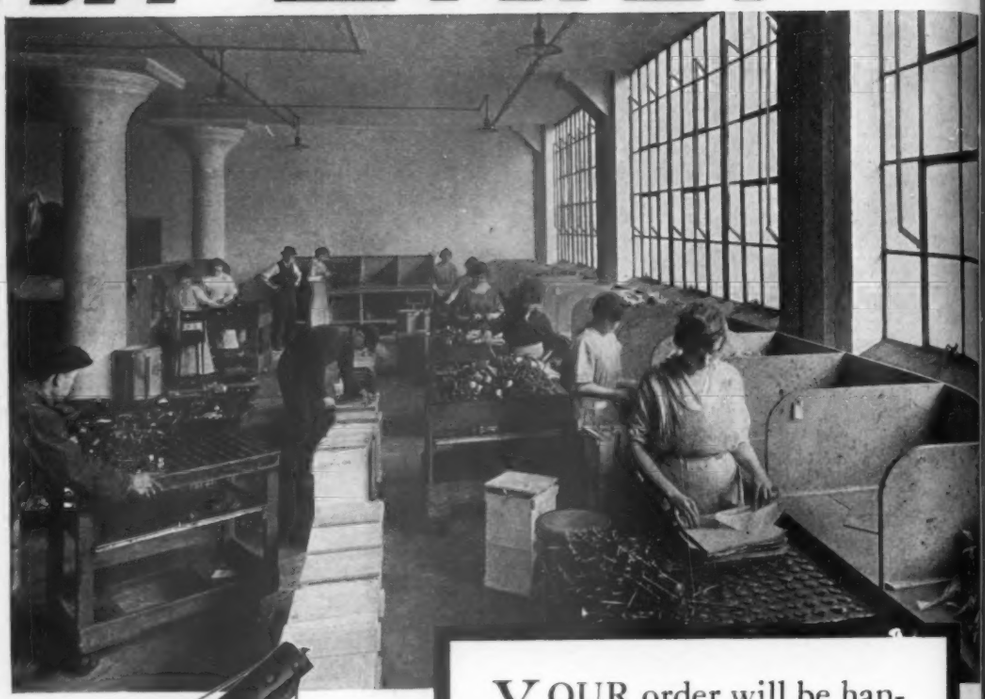

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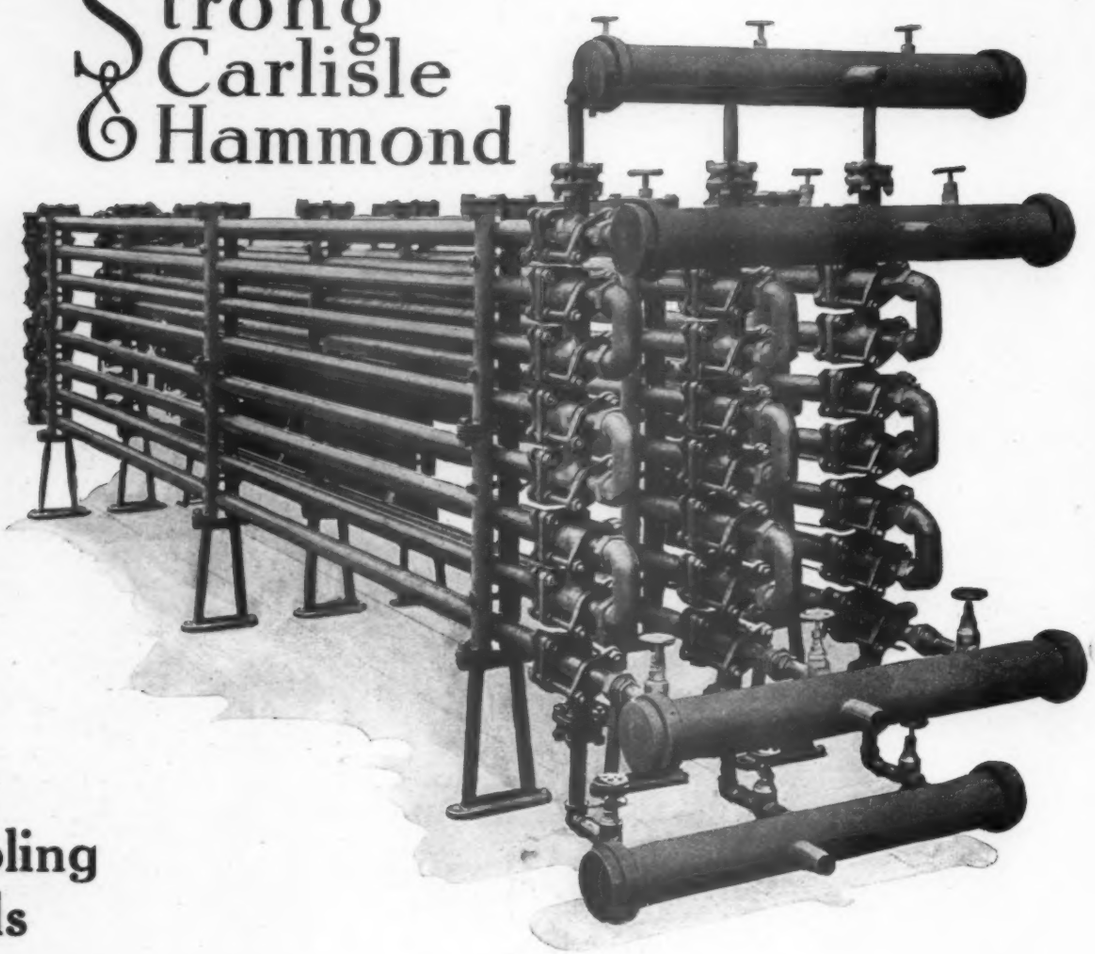

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DECEMBER 1, 1918

AVIATION
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VOL. V. NO. 9

Member of the Audit Bureau of Circulations

INDEX TO CONTENTS

	PAGE
The Hispano-Suiza Aircraft Engines	549
An All-American Fighting Airplane	554
Organizing for Aircraft Production	558
Future of the Aircraft Industry	560
Book Reviews	562
Performance and Cost of the Air Mail Service	563
The Proper Function of the Elevator	564
Corrosion Prevention on Aircraft Metal Parts	565
New Type of Rotary Engine	566
Digest of the Foreign Aeronautical Press	567
News of the Fortnight	658

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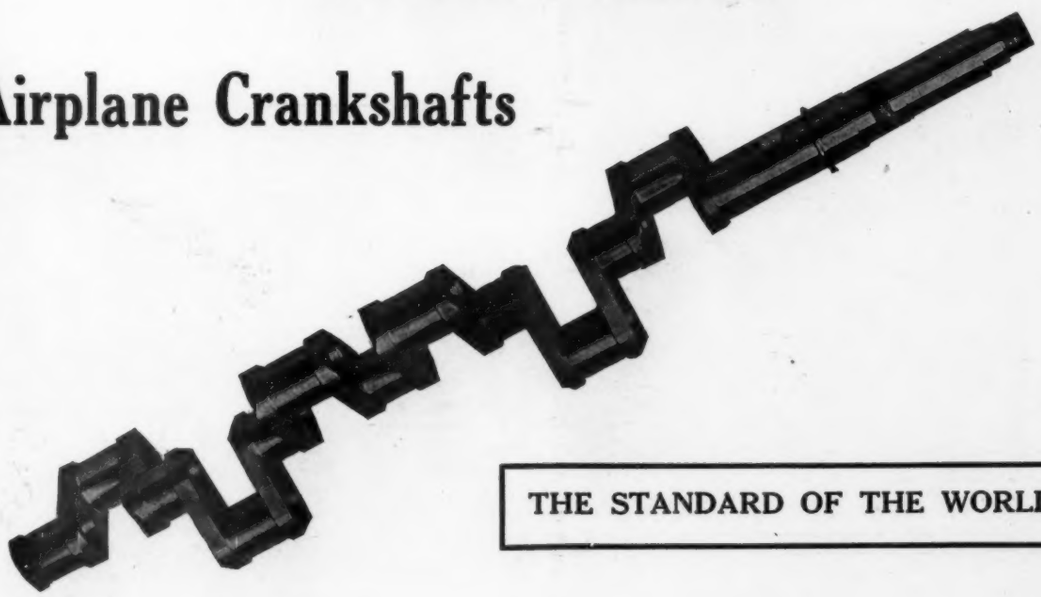

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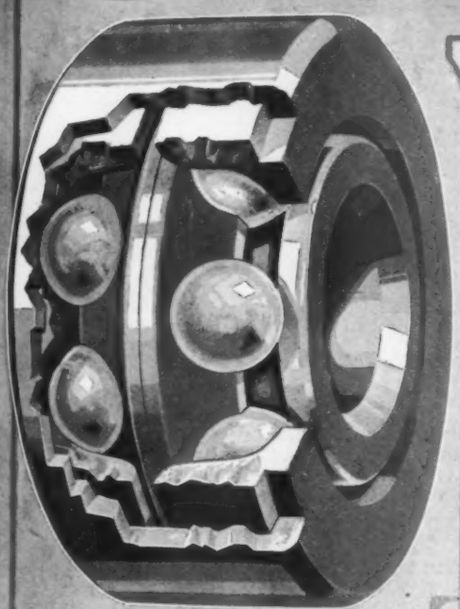

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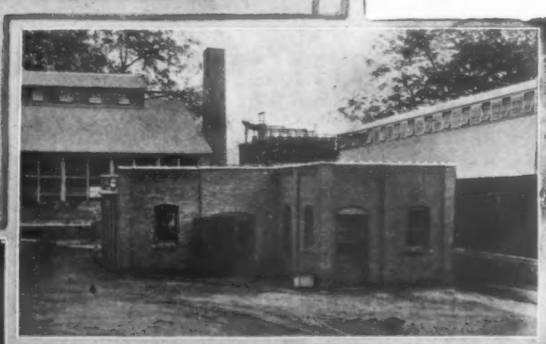
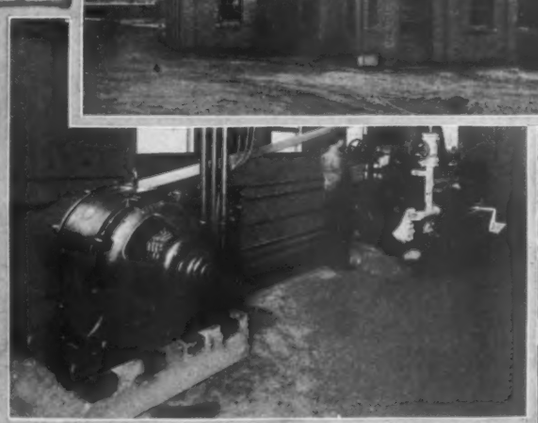
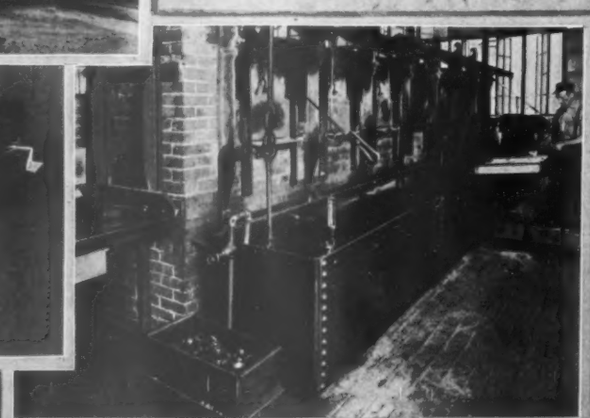


We here illustrate: Quenching vat in the heat-treating of ball races. The highly combustible oils used, require this special refrigerating plant. The cooling action of this system on the quenching fluid is equivalent to 75 tons of ice every 24 hours.





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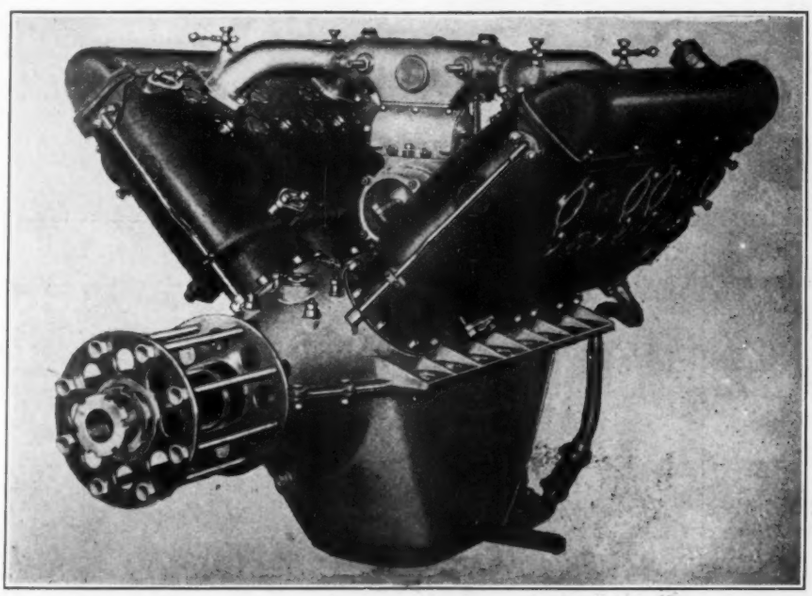
Vol. V | December 1, 1918 | No. 9

The Hispano-Suiza Airplane Engines

Owing to the veil of secrecy which has surrounded the Hispano-Suiza engine in this country up to the present time, the American public does not know that this engine has been characterized as second only to the Liberty as a factor in the air program of the United States. Thousands of Hispano-Suiza power plants have been built in this country since the beginning of the war, and the Government has awarded contracts calling for the manufacture of many thousand more. Yet, so closely has every detail of its construction been guarded, even engineers who were familiar with the Hispano-Suiza automobile engine of ante-bellum times are entirely unacquainted with its design as developed for aviation purposes. The story of its evolution has been called one of the most interesting romances of business arising from war requirements.



PROPELLER END VIEW OF MODEL I

Origin of Design

Marc Birkigt, a Swiss designer of mining machinery, employed in Barcelona, Spain, was asked by the directors of his company to design an automobile which would give consistent performance on the rough Spanish roads. Accordingly, he developed the Hispano-Suiza, named from the nationality of the company which built it and that of its designer, and meaning Spanish-Swiss. The most unusual feature of this car was its four-cylinder engine, which embodied the fundamental principles forming the basis of construction for the present-day aircraft engine bearing the same name.

When the Hispano-Suiza chassis was exhibited at the Paris Automobile Salon in 1906, it excited so much interest that a factory was established to build Hispano-Suiza cars in some abandoned street car sheds in one of the suburbs of the French capital. Hispano-Suiza racing cars soon became prominent in European speed and endurance contests. In 1913 the company was recognized as one of the leading manufacturers of Europe, and was operating a modern factory near Paris. At the outbreak of the war this factory was turned over to the Gnome company, which was engaged in manufacturing rotary aviation engines. Birkigt retired to Barcelona, where he busied himself in designing the prototype of the present Hispano-Suiza aircraft engine.

All the leading French manufacturers were working at this time to evolve a stationary aviation engine which would enable their flyers to compete at least on equal terms with the Mercedes-engined German planes. Up to that time the great majority of French aircraft engines had been of the rotary type such as the LeRhone, Clerget and Gnome, the most powerful of these developing only about 90 hp.

Joffre Takes Up Hispano-Suiza

Although the Hispano-Suiza aircraft engine, essentially a coupling together in V form of two four-cylinder automobile power plants, showed every indication of superiority to other aircraft engines then in use, the French military authorities failed to take advantage of its possibilities for several months. It was only at the intervention of General, now Marshal, Joffre that the prejudice against the use of any engine not of French design was overcome, and Major LaGarde was dispatched to Barcelona to investigate the engine. His report was so strongly in favor of the adoption of the Hispano-Suiza for the French air service that this was done in December, 1915.

Later Models

French aviators took kindly to the Hispano-Suiza, especially for fighting work. Its great power, flexibility, climbing qualities and reliability constituted an important factor in enabling the French and Allied air forces to wrest the supremacy of the air from the Germans and to maintain it.

The first Hispano-Suiza engines used on the Western front were the Model A, 150 hp. This was so successful that a more powerful engine was designed by Birkigt at the request of the French government, the Model E, 180 hp., which was completed in December, 1916. The Model E had higher compression and a large carbureter than the Model A, and was designed to operate at a speed of 300 r.p.m. faster.

Having been beaten in speed, the Germans strove to get the upper hand by attaining a greater ceiling. The new engine enabled the French aviators to retain their superiority in that respect also, as it allowed the pilot to maintain his power at great altitudes. Most of the fighting took place between 15,000 and 18,000 ft., and the Hispano-Suiza performed very consistently at this height.

A 200 hp. Hispano-Suiza appeared in March, 1917, with provision for carrying an extra gun. This engine was widely used in Flanders and on the Aisne. A 200 hp. type with high compression was built in July, and soon afterward the 300 hp.

Hispano-Suiza engine, known as model H, was put under test.

Used by Famous Aces

Although the exploits of the leading French aces are familiar to every one, comparatively few people are aware that most of them drove planes equipped with Hispano-Suiza engines. Among these the names of Fonck, Guynemer, Nungesser, Lufbery, and a score of others, are worthy of mention. Many British and American aces owe their lives and their citations and medals to the dependable performance of their Hispano-Suiza power plants.

Holds World's Altitude Record

Hispano-Suiza engines have held the world's record for altitude for some time, the most recent one having been established at Dayton, Ohio, Sept. 18, 1918. This flight was made by a captain in the Air Service of the United States Army, who attained a height of 29,200 ft. in a Bristol biplane driven by a 300 hp. Hispano-Suiza engine. That he did not continue upward was not due to limitations in engine performance, but because of the extremely low temperature, which taxed the powers of endurance of the pilot to the utmost. At 29,000 ft. the temperature was near 26 deg. Fahr. below zero. On alighting, 200 miles from his starting-point, the aviator found that he had frozen his lips and four fingers.

Design Is Patented

The Birkigt patents cover the manufacture of all Hispano-Suiza engines. These patents are owned by the designer of the engine, Marc Birkigt, and the parent company, Automoviles Hispano-Suiza, which has a factory at Barcelona, Spain.

Advantages in Construction

Great lightness and flexibility, high-power development, simplicity of design and ease of manufacture are characteristic of Hispano-Suiza construction. Less labor and raw material are required for manufacturing the Hispano-Suiza than for any other power plant of similar capacity which is being built at the present time. A comparison with the German Mercedes aircraft engine furnishes a striking illustration of Hispano-Suiza simplicity, the Mercedes having about 900 parts to 400 in the make-up of the Hispano-Suiza. It is stated that the amount of material needed for a Hispano-Suiza engine weighs one-third less than that required for a Mercedes engine of the same power development.

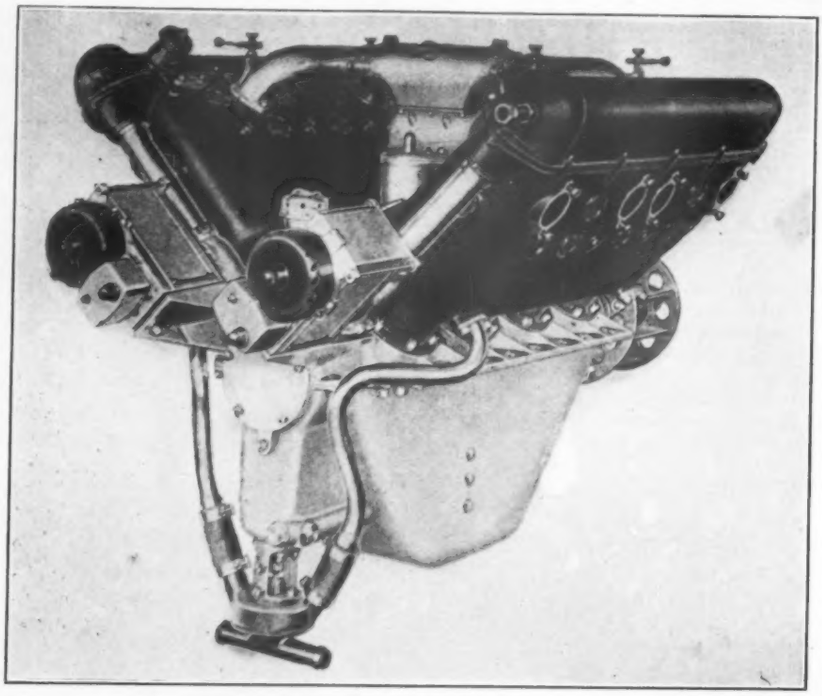


FIG. 2. ANTI-PROPELLER END VIEW

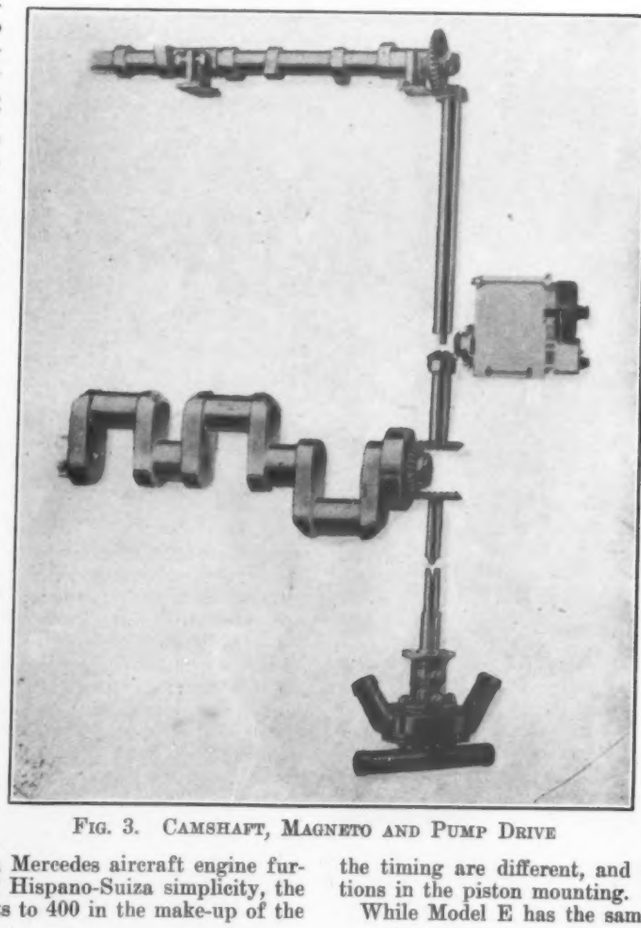


FIG. 3. CAMSHAFT, MAGNETO AND PUMP DRIVE

150 a Day in Europe

Approximately 150 Hispano-Suiza engines a day are produced in European factories, 120 being the average daily output of the seventeen French factories engaged in this work. The parent company at Barcelona, Spain, is producing regularly, and one of the two companies in England building the Hispano-Suiza is turning out about ten a day. A company has been formed in Italy and another in Japan to produce Hispano-Suiza engines, but neither has started production.

Big Factor in U. S. Program

European factories could not meet the demand for Hispano-Suiza engines in 1916, so manufacturing rights were given to the Wright-Martin Aircraft Corporation, New Brunswick, N. J. This organization has been producing these engines ever since in constantly increasing quantities. On the entry of the United States into the war, orders were issued by the American Government for thousands of Hispano-Suiza engines to meet the requirements of all branches of the Air Service. As these orders were placed, the Wright-Martin Corporation made arrangements with other plants to take on work as sub-contractors.

Four Types Made Here

Four models of Hispano-Suiza engine have been produced in the United States. These are designated Models A, I, E and H.

Model A has a bore of 120 mm. (4.72 in.) and a stroke of 130 mm. (5.11 in.), and develops 150 hp. at 1450 r.p.m. at sea level. Although formerly used for combat and pursuit work, this engine has now been relegated to use in training planes.

Model I, also of 150 hp., is the same as Model A, except that it has the new straddle fork type of connecting rod, the magneto drive and the timing are different, and there are some slight modifications in the piston mounting.

While Model E has the same bore and stroke as Models A

and I, it develops 180 hp., the compression ratio having been raised from 4.72 to 1 in the Model I to 5.33 to 1 by increasing the distance from the center of the piston pin holes to the top of the piston. A larger Stromberg carbureter with 2-in. barrels is used instead of the smaller one fitted to the Model I. This is necessary to take care of the increased volume of mixture required by the higher-engine speed of the Model E, this being 300 r.p.m. greater than in the Model I. The Model E has been widely employed fitted to British SE-5 planes, which are designed for combat and general purpose work.

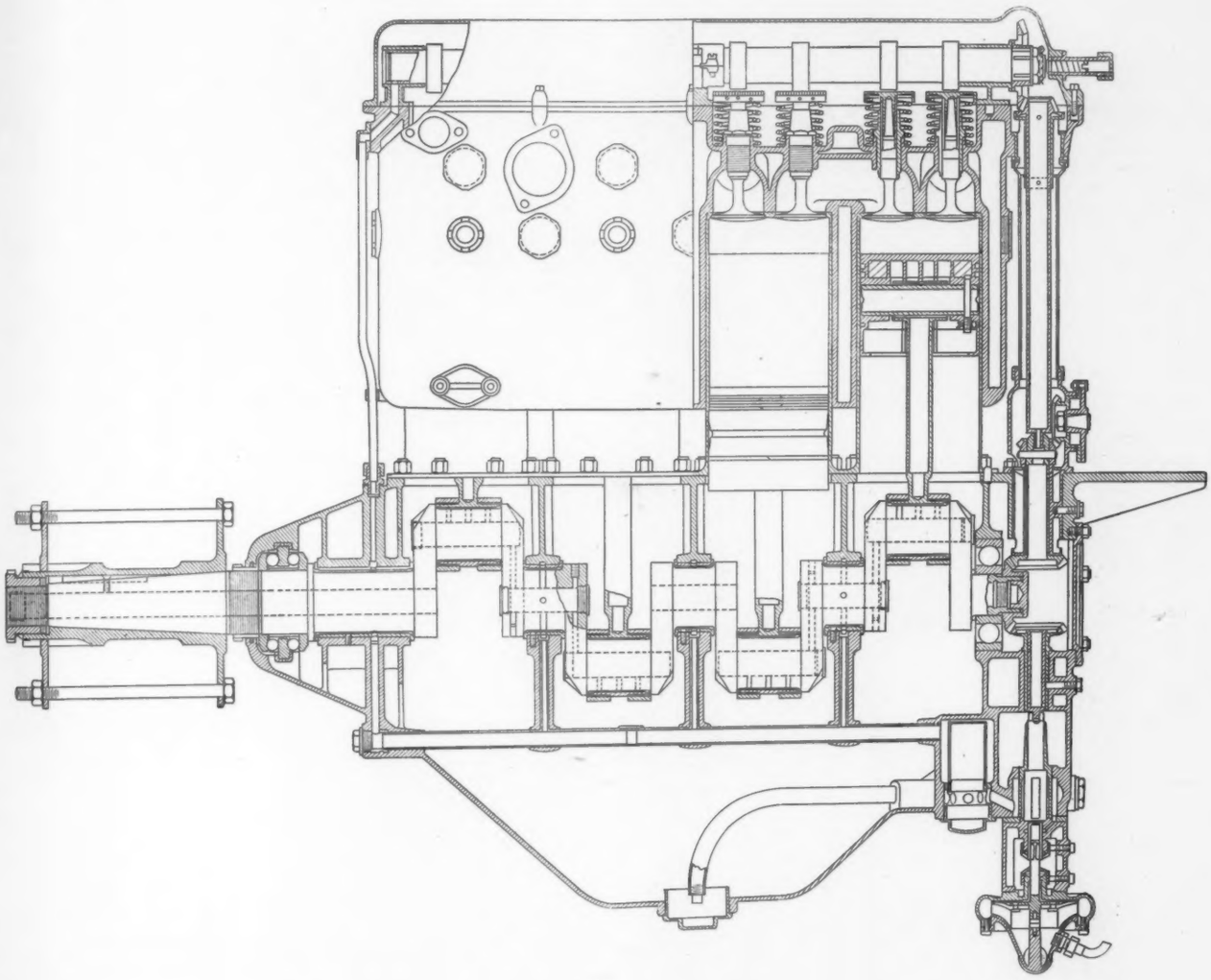


FIG. 5. CROSS SECTIONAL DIAGRAM, SIDE VIEW

The three models mentioned above resemble the original French design very closely in their essential features, although incorporating a number of variations in dimensions and details of design.

The 300 hp. type, Model H, may be characterized as entirely American except for its basic principles. The Wright-Martin experimental department at New Brunswick has completed about twenty of these engines, and they are stated to have proved unusually powerful and speedy. The bore of the Model H is 140 mm. (5.511 in.) and the stroke is 150 mm. (5.905 in.). Two other important features which are different in the Model H as compared with the other three engines are the carbureter and oiling system. Like the others, however, this model is designed for fighting, pursuit and similar activities.

Mechanical Details

The Model I Hispano-Suiza may be described as typical of the entire series, with the exception of the points of difference outlined above. It is a fixed-cylinder, water-cooled engine, with eight cylinders arranged in two blocks of four, which are set at an angle of 90 deg. The aluminum crank case is divided at the center line of the crank shaft, the faces of the two halves being ground to a perfect fit, as no gasket is used between them. They are fastened together by bolts. The lower half of the crank case is unusually deep, forming a large oil reservoir and also stiffening the engine. The upper half carries the two-cylinder blocks, flanges at the base of the cylinders being attached by means of bolts.

Four-Throw Crank Shaft

A four-throw crank shaft is used, 180 deg. between throws. It is made of chrome nickel steel, machined all over and is hollow for lightness. Four plain main bearings, bronze backed and lined with babbitt, and one annual ball main bearing at the rear (magneto end) of the engine carry the shaft, which is supported between the crank case halves. A double-row, ball-thrust bearing located in the front of the crank case takes the thrust of either a tractor or pusher propeller. The crank shaft is provided with a taper at the front end, having a key for the propeller hub.

Aluminum Cylinder Blocks

The cylinder blocks are of cast aluminum and incorporate water-jackets surrounding the heads of the forged steel cylinders, which are made in the form of sleeves, threaded on the outside to screw into corresponding threads, which are quickly

and easily cut in the cylinder blocks by means of large compressed air taps. Each cylinder is flanged at the bottom and closed at the top, the upper surface being flat and carrying the two valve seats. The cylinder blocks also embody the intake and exhaust passages and the valve ports.

and hollow in construction. These pins float in both sides of the piston, as well as in the upper end of the connecting rods, a piston pin-lock ring holding each pin in place.

Overhead Camshafts

The overhead camshaft which operates the valves in each

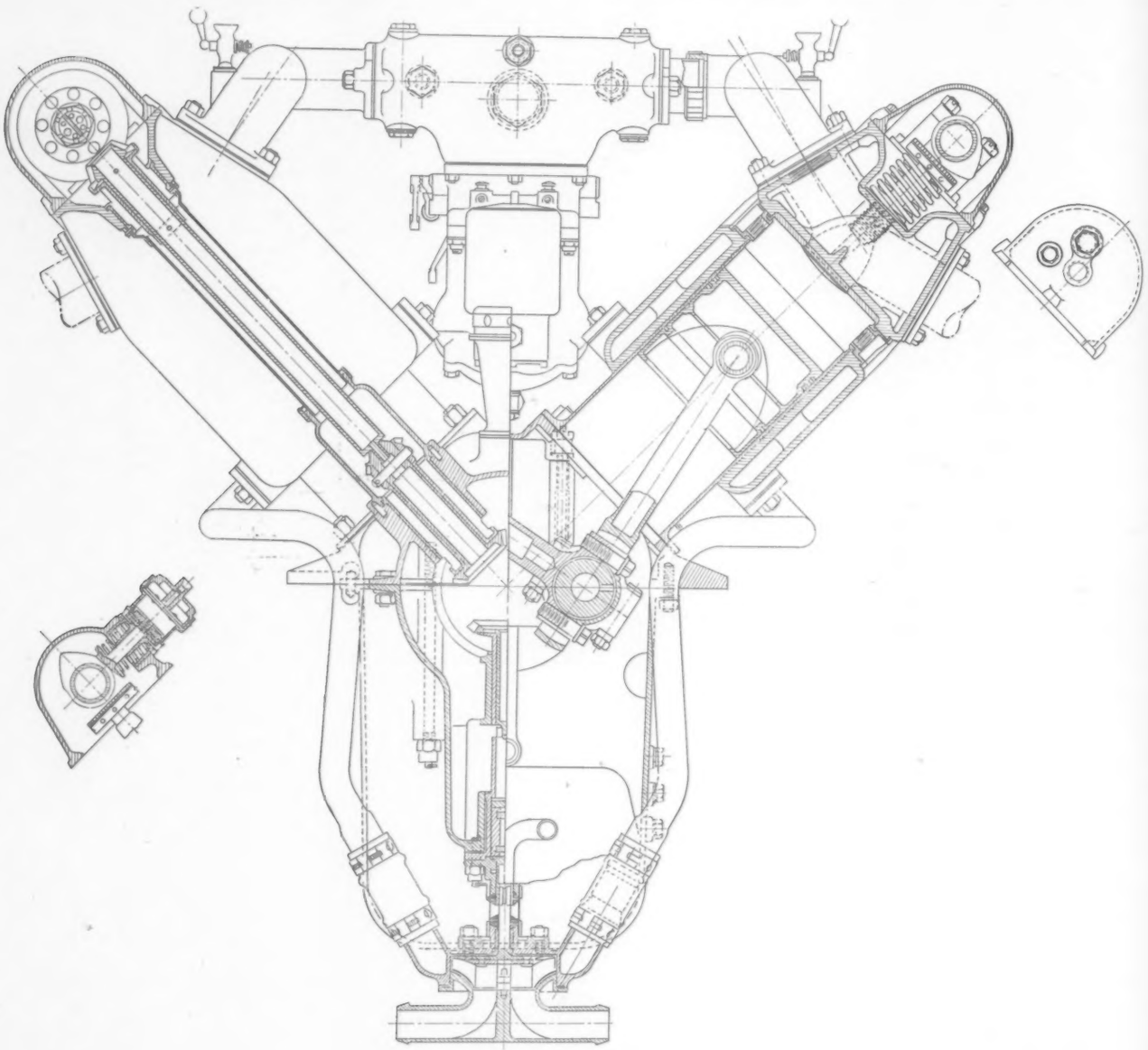


FIG. 4. CROSS SECTIONAL DIAGRAM, END VIEW

Tubular Connecting Rods

The connecting rods are of heat-treated steel and tubular in construction. The new straddle fork type of rod, which is of American design, is forked at the bottom and bolted to a two-piece bronze box lined with babbitt, two bolts being used at each side. The bronze box bears directly on the crank shaft, and the other connecting rod bears on the outer and central portion of the bronze box, the shaft itself working between the forked ends of the straddle rod. Bronze bushings are provided at the upper ends of each pair of connecting rods.

Cast Aluminum Pistons

Pistons are of cast aluminum, 3/8 in. thick at the head, the sides tapering from 3/8 in. at the top to 1/2 in. thickness at the bottom, this taper construction facilitating the dispersion of the heat of combustion. There are four narrow rings in two grooves at the top of each piston, and near the bottom there is one oil ring with relief just below it. Case-hardened alloy steel is used for the piston pins, which are of large diameter

cylinder block is hollow and carried in three plain bronze bearings, each shaft being driven by two pairs of bevel gears and a vertical shaft connection to the crank shaft at the rear of the engine. These vertical shafts are protected by light steel tubing, and each is made with a screw-driver, or Oldham coupling, type of joint slightly below the middle to permit removing the cylinder blocks without dismantling other parts. One of the camshafts, that in the left-hand block, besides operating the valves, drives the piston of a small air pump mounted on the valve gear housing. This pump is used for maintaining pressure in the gasoline tank where the pressure fuel feed system is used. The oil tight cast aluminum housings which inclose the camshafts and valve mechanism are easily removable.

No Rocker Arms Used

Valves are of tungsten steel with large diameter hollow stems, working in bushings of cast iron. They are set vertically in the cylinders along the center of each block, and the

overhead camshafts operate them directly by making contact with case-hardened, flat-headed adjusting disks at the upper ends of the stems, rendering rocker arms unnecessary. Each valve is held to its seat by two concentric helical springs, either one of sufficient strength to insure proper seating if the other breaks. A further advantage of this construction is that it affects more rapid and more positive opening and closing of the valves. Clearance between the cam contour and the adjusting disks may be easily corrected when necessary by means of serrated washers pressed upward by the springs which hold the adjusting disks in place, permitting easy turning with a special wrench, which displaces the adjusting disks angularly in the valve stems. The whole assembly can slide freely lengthwise, although the spring retainer washer is held in place angularly by tenons engaging slots in the stem.

Pressure Lubrication System

A positive pressure system is used for lubrication, the oil being forced to the bearings, etc., by a sliding vane eccentric pump mounted vertically in the lower half of the crank case immediately under the rear end of the crank shaft. This pump is driven at 1.2 times crank shaft speed by the same bevel gear on the crank shaft that drives the vertical shaft at the rear of each cylinder block. Where an oil radiator and reserve reservoir are used, practically no oil is carried in the sump of the crank case, this being known as the dry sump system. In this case the oil is circulated through the oil radiator and reservoir by a gear pump situated on the magneto support bracket at the rear of the engine and driven from an extension of the crank shaft.

Oil is forced by the vane pump first through the filter in the lower half of the crank case and then through a steel tube cast in the lower half of the case, with connections leading to three of the main bearings, where the oil enters the hollow crank shaft and is distributed to the four crank pins. Oil is fed to the outer connecting rods through holes in the inner rods, and is then diffused as a spray, which combines with the oil thrown from the main crank shaft bearings to lubricate the cylinders, pistons and piston pins. At the front main bearing there is a by-pass leading around the outside of the bearing to a tube which runs up the front end of each cylinder block, the lubrication of the bearing itself being taken care of by an oil lead. Passing up the tubes at the front of the engine, the oil is delivered to the hollow camshafts, which distribute it through small holes to the bearings, cams, valve tappets and stems, the excess oil escaping through the rear end of the camshafts in the form of a stream which lubricates the vertical shaft bearings and driving gears before returning to the crank case through the vertical shaft housing at the rear of the engine. The filter in the crank case is fitted with a removable screen to permit easy inspection and cleaning.

Double Magneto System

Two eight-cylinder magnetos are used, each firing two spark plugs per cylinder. These magnetos are the Dixie type 800. A cast aluminum support at the rear of the crank case carries them both, and they are driven at crank shaft speed by a transverse shaft and gear type couplings. A small shaft at right angles to the transverse shaft and directly beneath it, being located in the center of the magneto support bracket, communicates the drive from the crank shaft to the transverse shaft by means of a spiral gear. The left-hand magneto runs clockwise, and the right-hand instrument turns in an anti-clockwise direction.

The spark plugs are located in bushings in the aluminum cylinder blocks, one of the bushings being on the inboard side of the combustion chamber of each cylinder and the other on the outboard side.

The firing order is as follows, L indicating the left-hand cylinder block and R the right-hand block, facing toward the propeller end of the engine and the numbers denoting the position of the cylinders, facing toward the rear of the engine:

1 L—4 R—2 L—3 R—4 L—1 R—3 L—2 R

Fitting a Starter

By bolting a suitable bracket in place of the magneto support in oil pump assembly, an electric or air starter may be fitted. A single-unit motor generator system may be used for a combination starter and long-distance wireless outfit, as the magneto wireless connection has a radius of only approximately 5 miles. Engines used in pusher type seaplanes are sometimes equipped with a geared-down, hand-starting crank, with a small magneto to give a hot spark at low speed.

One Carbureter Used

The Stromberg carbureter meters and discharges the fuel by the suction set up in the delivery of air through the venturi tubes to the carbureter. The fuel delivery is kept in proportion by the induction of air into the jet, thus maintaining a constant mixture throughout the throttle range.

Fuel System

When arranged for gravity feed, the gasoline tank is placed so that it will give 1 to 2 lb. head at the carbureter for any position of the machine when in flight. Where pressure feed is used, the pressure is maintained by the pump located on the valve gear housing of the left-hand cylinder block, a relief valve being placed in the line to prevent the pressure at the carbureter becoming greater than 2 lb. This valve is designed so that it can be adjusted in accordance with the varying altitudes at which the machine travels. Sufficient pressure for starting is obtained by using a hand pump when this system of fuel feed is employed. It desired, a vacuum tank system may be used, the vacuum being usually secured by taking a lead from the throat of a compound venturi, placed in the draft of the propeller, to the main gasoline tank, a check valve being placed in the line and a branch line leading to the auxiliary fuel tank.

Cooling System

The engine cooling water is circulated by a centrifugal pump with two discharge outlets which is mounted directly underneath the oil pump. The water pump is driven from the same shaft as the oil pump at 1.2 times engine speed. Its capacity is 100 liters (26.50 gal.) per minute at an engine speed of 1450 r.p.m. The cylinder water-jackets have a capacity of 18½ liters (4.9 gal.) or, by weight, 18½ kg. (41 lb.).

Machine Gun Drive

An interrupter driving mechanism is used to fire a machine gun which is synchronized with the propeller. This mechanism is operated by a gear pinned to the lower gear on the lower half of the vertical shaft, which drives the camshaft of either the left or right-hand cylinder block. Two ball-bearings carry the interrupter shaft, which is driven at crank shaft speed. It is bolted by a double flange connection to the driving shaft, one flange having one less bolt hole than the other. When the firing mechanism is properly set, a bullet fired from the gun will miss the trailing edge of the propeller by ½ in.

Mounting Engine in Plane

In mounting the Hispano-Suiza engine in a plane, it is anchored on a rigid support, lined at the points of contact with fiber or sheet metal, the engine base being set flat on the support members. To facilitate disassembly, the camshaft and valve gear housings are usually left exposed, enabling the plane constructor to use smaller cowls. When an engine is mounted without cowls, it is necessary to protect the magnetos by covers, usually of leather.

To carry away any gasoline that may overflow from the bowl of the carbureter or drip back during maneuvers in the air, a small drain pipe is attached to a nipple at the bottom of the carbureter. The excess gasoline is discharged as far as possible to the rear under the planes and away from the exhaust line.

Commercial Possibilities

Those connected with the manufacture of the Hispano-Suiza engine, although appreciating the important part it has played in the great world war, predict that its importance as a factor in the future development of aircraft for commercial purposes will be still greater.

Aeronautical Patents

ISSUED SEPTEMBER 17, 1918

1,278,955—To George Lotysiewicz, Brooking, Saskatchewan, Canada. Boomb-dropper.

1,279,068—To Charles J. Yasensky, Weyburn, Saskatchewan, Canada. Combined aeroplane and balloon.

1,279,231—To John Frederocl Billenstein, Cleveland, Ohio. Flying machine.

1,279,127—To Christopher J. Lake, Bridgeport, Conn. Aeroplane.

1,279,133—To Richard McMyers, Bridgeport, Conn. Stabilizer.

The L-W-F Model G-2 Fighting Airplane

By Glenn D. Mitchell
Chief Engineer, L-W-F Engineering Co.

Since the entry of the United States into the World War, no all-American designed fighting airplane has been used at the front. In the great rush and hustle to get American-made fighting machines to the battle front, no time was given American engineers and designers to perfect any partially constructed or designed machines of the type required. Contracts were placed immediately for the more successful designs of the Allies and all that was left for American engineers to do was to use their utmost ingenuity to adapt American production methods to these foreign types. This they did with such success that the airplane production has been more than sufficient. But, true to American tenacity these engineers did not give up hope and very quietly several of them worked up designs of fighting machines, e perimental models of which have since demonstrated their ability to compete successfully with, if not exceed, the performances of the foreign designs for the same purposes.

FIG. 1. SIDE VIEW OF THE MODEL G-2

Among the most successful of the all-American designs is the L-W-F machine, the first experimental model of which was in the air early in January, 1918. This first machine, known as Model G, which is shown in Fig. 2, was powered with a Liberty-12 motor and was taken off with the wind, looped and tailspun the first time it was in the air.

Model G-1, an improvement over Model G, was built and flown successfully during the summer of 1918, demonstrating before various government officials its speed, climb and carrying capacity. This machine, loaded as a fighter with full tanks, seven machine guns, ammunition, pilot and gunner, made 128 m.p.h. and climbed 10,000 ft. in ten minutes.

Later in the summer, Model G-1 was radically changed into Model G-2 by cutting off the overhang, balancing all control surfaces, doubling the number of wing ribs and later installing a wing curve radiator. The following description refers to the latter machine, Model G-2, which, as before stated, is a modification of Models G and G-1.

General Description—Model G-2 is a general service, 425-450 hp., two man biplane of the land tractor, military type, armored, and carries an armament of seven machine guns. In addition it can also be equipped with four large bombs. As will be noted, a wing nose radiator was used at the time the photos for the accompanying figures were made. All parts of the machine seen from above are finished in earth brown, while from below it is sky blue. The general specifications follow:

DIMENSIONS:

Overall width, 41 ft., 7½ in.
Overall length, 29 ft., 1¼ in.
Overall height, 9 ft., 4⅝ in.
Tread of wheels, 5 ft. 6 in.
Wheels, 26 in. x 4 in.

WINGS:

Wing Curve, L-W-F No. 1 (modified R. A. F. 6), upper and lower wings.
Incidence: Lower wing, 0 deg.; Upper wing, + 1 deg.
Decalage, 1 deg. Chord, 80 in., upper and lower.
Dihedral, 0 deg. Gap, 72 in., nose to nose on vertical line with body horizontal.
Backsweep, 0 deg. Stagger, 7⅛ in. (positive).
Span: Upper wing including ailerons, 41 ft., 7½ in.; lower wing, 38 ft., 5¾ in.
Aspect Ratio: Upper wing including ailerons, 6.3; Lower wing, 4.78; average, 5.54.

AREAS:

Total supporting aera (including ailerons), 515.54 sq. ft.
Net area of main wings (not including ailerons), 465.46 sq. ft.
Net area of upper wings (including ailerons), 268.78 sq. ft.
Net area of upper wings (not including ailerons), 218.70 sq. ft.
Net area of lower wings, 246.76 sq. ft.
Total area of one aileron 25.04 sq. ft.; balanced area, 1.95 sq. ft.
Total area of both ailerons, 50.08 sq. ft.
Total area of one elevator, 13.85 sq. ft.; balanced area, 1.5 sq. ft.
Total area of both elevators, 27.70 sq. ft.
Total area of rudder, 12.65 sq. ft.; balanced area, 1.31 sq. ft.
Total area of horizontal stabilizer (both sides), 29.15 sq. ft.
Total area of vertical stabilizer, 5.21 sq. ft.

CONTROLS AND CONTROL SURFACES:

Dual stick control. Aileron wires enclosed in wings.
Horizontal stabilizer double camber with center line set at 0 deg. to thrust line.
Elevator curve included in stabilizer curve.
Aileron curve included in wing curve extended.
Rudder and vertical stabilizer flat.

POWER PLANT:

Liberty 12-cyl. engine, direct connected, 435 hp. at 1700 r.p.m.
Air screw, 2 blade, tractor, diameter 9 ft., 7 in.; average pitch, 7.38 ft.
Propeller turned 1800 r.p.m.

WEIGHTS:

Case 1. Weight of complete machine, empty with gun mounts, but no guns: 2675 lb.

Case 2. Equipped as a fighter.

Weight, light	2,675.5	lb.
90 gal. gas	553.5	lb.
14 gal. water	118.	lb.
6 gal. oil	44.	lb.
Ammunition	150.	lb.
7 machine guns	152.	lb.
2 men	330.	lb.
Total full load	4,023.	lb.

Case 3. Equipped as a bomber.

Weight, light	2,675.5	lb.
120 gal. gas	752.	lb.
6 gal. oil	44.	lb.

14 gal. water	118.	lb.
Ammunition	150.	lb.
7 machine guns	152.	lb.
Armor	66.	lb.
4 bombs, rack and release	592.	lb.
2 men	330.	lb.
Total full load	4,879.5	lb.

LOADINGS (Based on 515.54 sq. ft. area and 435 hp.

Case 1.	Loading per sq. ft.	= 5.185	lb.
	Loading per horse power	= 6.15	lb.
Case 2.	Loading per sq. ft.	= 7.82	lb.
	Loading per horse power	= 9.25	lb.
Case 3.	Loading per sq. ft.	= 9.47	lb.
	Loading per horse power	=11.22	lb.

PERFORMANCE:

High speed at 10,000 ft.	= 130 m.p.h. (loaded as in Case 2)
High speed at low altitude	= 138 m.p.h. (loaded as in Case 2)
Low speed (landing)	= 50 m.p.h. (loaded as in Case 2)

Climb: Case 1. 10,000 ft. in 7 min. 28 sec.
Case 2. 10,000 ft. in 9 min. 18 sec.
Case 3. 10,000 ft. in 14 min. 45 sec.

ENDURANCE:
Four hours at full speed.

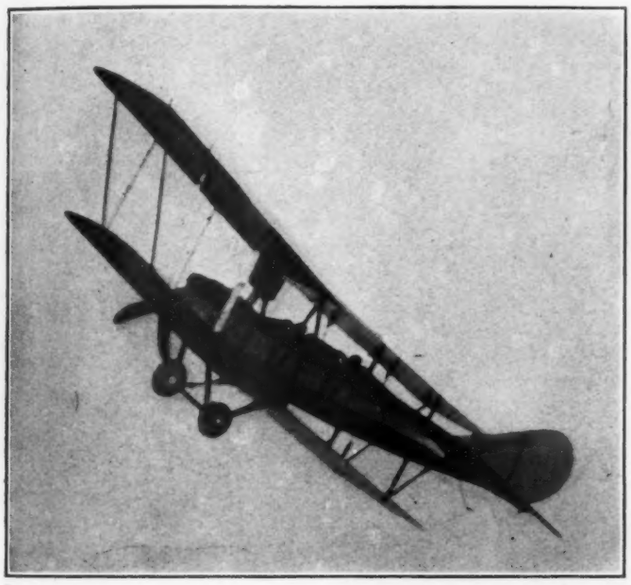


FIG. 2. MODEL G IN FLIGHT

Contructional Design—In the design of this machine the reduction of head resistance has been constantly kept in mind, all possible parts being well streamlined. The engine is almost enclosed, (Fig. 5, side elevation) only the cylinder heads being exposed, thus adding to the efficiency of the cooling system. The double wiring is streamlined with a grooved spruce strip taped between the two wires. The landing gear limbs and axle are streamlined with balsa wood fairing and the cockpits are enclosed as much as possible to offer the least head resistance.

Body—The body is of the monocoque type of construction, being built over a streamline shaped mould, of three layers of $\frac{1}{16}$ in. spruce, with linen tape wound spirally from tail to nose between the middle and inner and outer layers. The two inner laminations are spiraled in opposite directions while the outer lamination runs straight fore and aft. All three laminations and the two layers of tape are laid in hot glue. The outside is covered with linen doped on and enameled, making the complete shell approximately ¼ in. thick. This type of body requires no bracing except at the engine end and where the wings and tail skid are attached. The bracing at these points consists of six cold rolled steel plates formed of bent up angles and riveted to the inside of the body with hollow and solid rivets alternately. Plates one, two and three carry the engine beds; plates three and four carry the wing structure, while five and six support the tail skid. This gives a sturdy, resilient body and one which is easily repaired. The approximate weight of the finished body, including all bracing plates, engine beds, tinning around engine, stabilizer beam box, and tail skid complete is 260 lb. A similar type of body built by this company, failed under an official sand load test with a load of over 9,000 lb. in the engine section and an equivalent load of 55 lb. per sq. ft. on the tail surfaces.

Wings—There are two upper and two lower wing panels. The former are connected closely together at the center of the machine by external fittings, while the latter are hinged to a tubular framework suspended below the body and bolted to

FIG. 3. OBSERVER'S COCKPIT, WITH TWIN MACHINE GUNS

it at the brace plates. The space between the panels, which is a little wider than the body, is left open. The illustrations show the machine before this change was made. The rear edges of both upper and lower wings are cut away at the body to give a better vision and angle of fire. (Fig. 5, plain view).

The wing structure is of the familiar Pratt truss type with

FIG. 4. REAR COCKPIT, WITH THREE GUNS POINTING DOWN

two sets of struts on each side of the body and a cabane at the center over the pilot's cockpit. This cabane is composed of one steel tube center strut in front, with a combination of two spruce rear "V" struts and two diagonal streamlined steel tubes forming an oblique pyramid whose apex is at the rear center wing connection. This arrangement (shown in Figs. 3 and 4) gives better vision, more room and eliminates wire bracing thus making the pilot's cockpit easier to enter. The main wing struts are of solid spruce with metal sockets on the ends composed of a sheet steel skirt welded to a drop forged steel base. A tongue on the base is pinned between two lugs on the wing fitting. Each lower panel is fitted with a steel tube wing tip skid shown in Fig. 1.

The wings are built up in the more familiar way, using front and rear spruce I-beams routed out for lightness, the tongues of the wing webs fitting into the routing. The ribs are spaced approximately 7½ in. on centers being nearer together at the body end of the panel. The webs are of lightened bass wood and the caps are spruce. A strip of two-ply veneer covers the upper surface of the nose to the center of the front beam. Internal wing bracing is of the usual type.

Tail—The horizontal stabilizer is in two halves bolted to each side of the body. The front stabilizer beam projects at the inner end and mitres with the opposite beam in a rectangular steel box riveted inside the body. The stabilizer rear beam is also of spruce while the leading edge is a bent steel tube. To remove the complete stabilizer it is only necessary to take off the braces and take out four bolts.

The elevators are built up of spruce front and rear beams with wooden ribs and a flattened steel tube edge and are hinged to the stabilizer with male and female eyebolt hinges.

The aileron construction is similar to that of the elevator.

The rudder and vertical fins have steel tube frames filled in with wooden ribs.

Landing Gear—This is of the "V" type. Two inch by 13 gauge steel tubes are bent to form the limbs with hinge connections welded on each end. In the bottom of the "V" a 3/32 in. steel guide plate is welded. A bronze block, carrying the 2 in. diameter by $\frac{1}{16}$ wall chrome-nickel steel axle, slides in the guide. Steel spools are slipped on the axle at either side of the bronze guide block and over these and the bottom of the "V" the shock absorber of ⅝ Goodyear exerciser cord is sprung. A leather strap holds it in place. The "V" limbs are braced by two $\frac{1}{16}$ in. hard cables running respectively to opposite sides of the body and by two 1¼ in. steel cross tubes, enclosed in a balsa wood streamline notched out to contain the axle. Standard wire wheels are used, covered with doped linen.

The tail skid or skids, for there are two, are made of ash or hickory. The main tail skid (Fig. 5, side elevation) is swiveled with a universal joint where it passed into the body. The upper end of this skid is secured by rubber exerciser cords to body plate number 5. The other skid is a fixed emergency member to hold the tail high enough from the ground to protect the elevator arms should the main skid be broken.

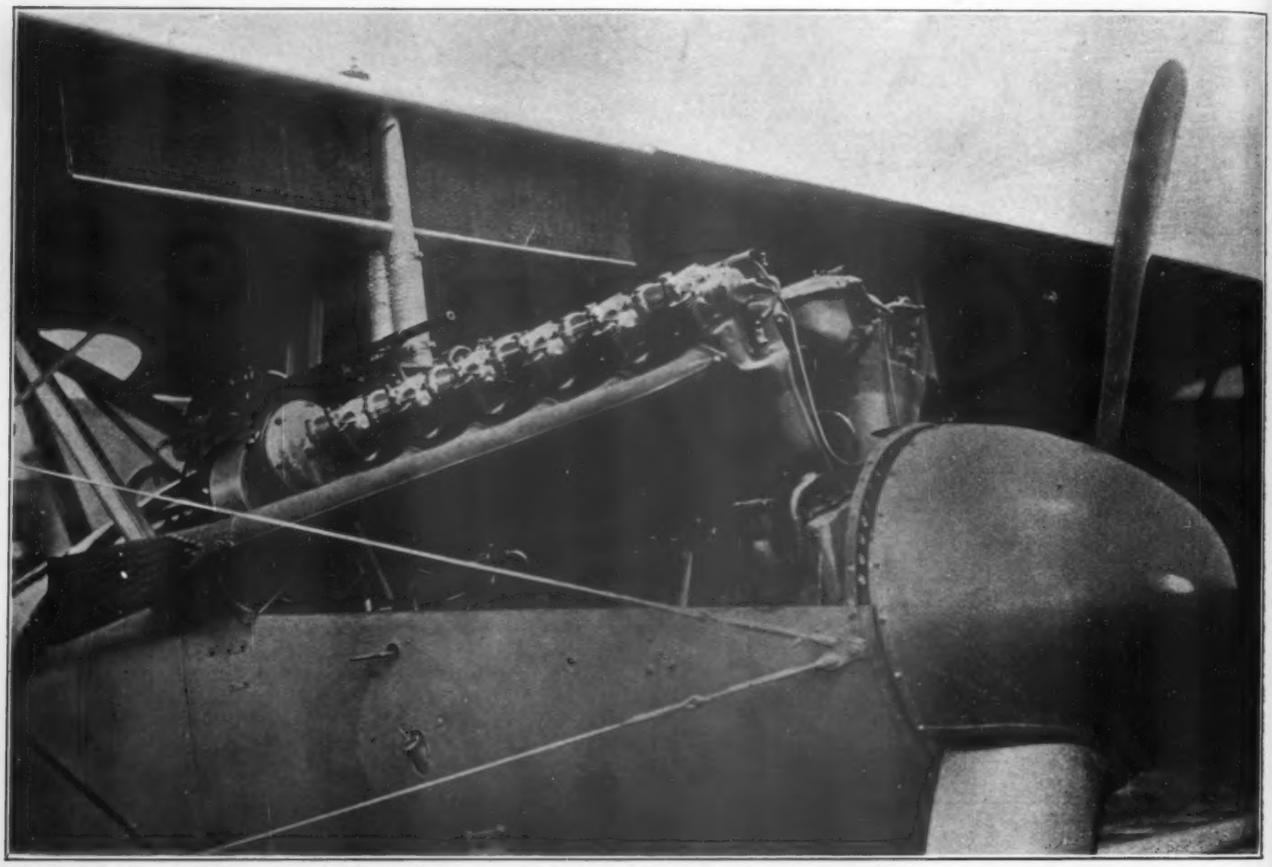


FIG. 6. THREE-QUARTER FRONT VIEW OF LIBERTY ENGINE AND FIXED MACHINE GUNS

Controls—A dual stick control is installed, with the stick in the gunner's cockpit removable. The rudder is connected in the customary way, while the elevator wires run to arms on the outside of the body. The aileron wires are enclosed in the wings and run directly into the body to a quadrant on the control shaft.

Exhaust—The engine is equipped with exhaust pipes terminating in a Spad type of muffler (Fig. 6).

Fuel System—There are two main gas tanks, one between pilot and engine, and one built under and around the pilot's seat. A smaller auxiliary tank is between the pilot and gunner. An air pressure system is used, there being an auxiliary hand pump in each cockpit, so that in case of emergency the gunner can help the pilot keep up the pressure. Shut-off valves in the main line are operated from the pilot's seat.

An auxiliary oil tank is placed beneath the engine feeding direct into the oil pump.

Engine Controls—The spark and throttle levers are at one side of the pilot, on the inner surface of the body, and operate the engine through rods and bell cranks.

Airscrew Nose—For reducing head resistance by perfecting the streamline the airscrew hub is covered with a spun aluminum cowl, or nose. This part is cut to fit the blades of the airscrew and bolted to a flanged up spider caught under the heads of the airscrew bolts.

Cooling System—As shown in Fig. 6, the upper water pocket of the radiator is built into the wing curve. This radiator proved very satisfactory and was only replaced into

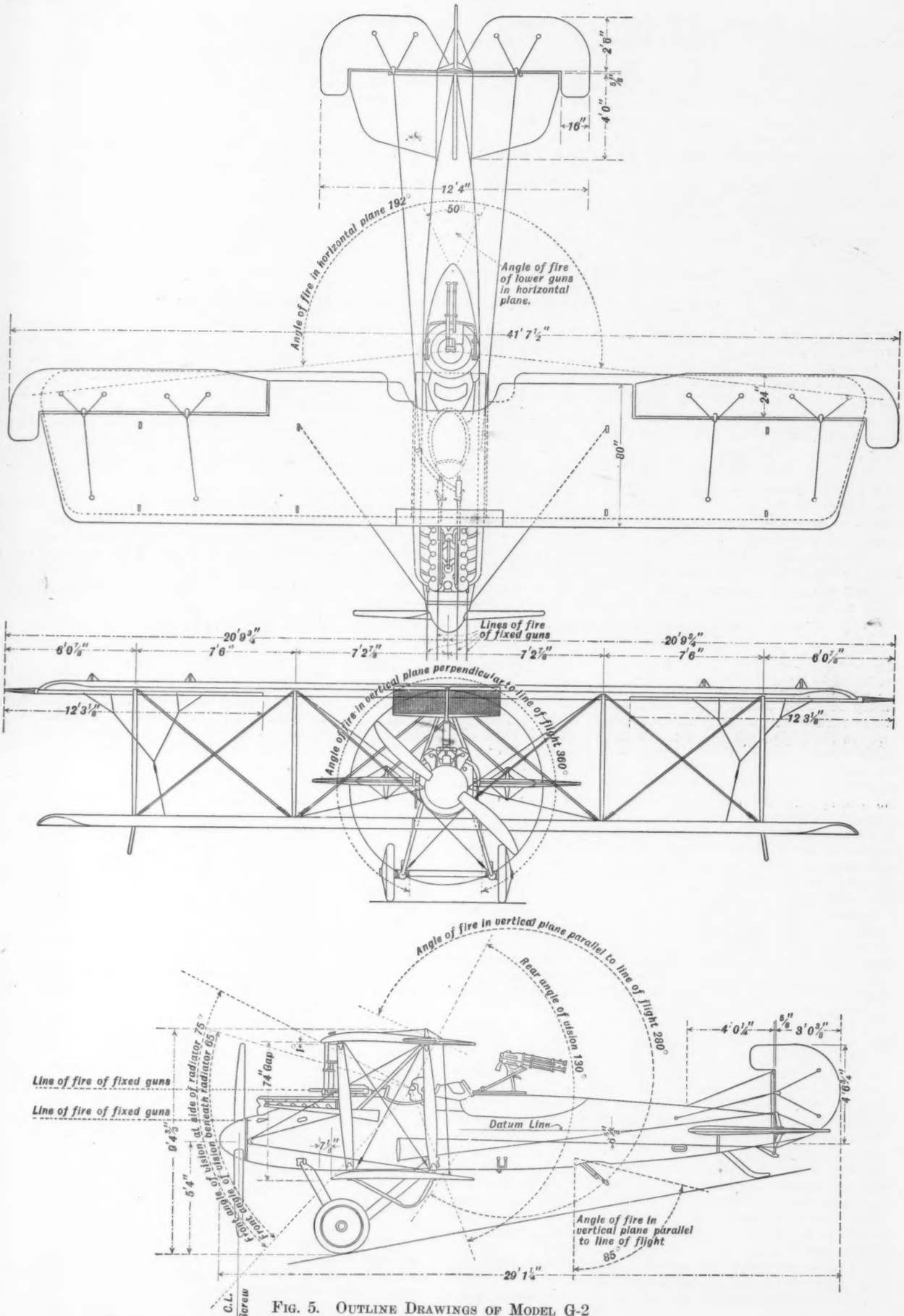


FIG. 5. OUTLINE DRAWINGS OF MODEL G-2

the wing to give the pilot a larger field of view ahead. The radiation is Ajax, ¼ in. cells and 5 in. core. The face dimensions are 10 in. x 60 in.

A unique method of controlling the temperature of the engine with this installation consisted of a cross-over between the inlet and outlet pipes to the radiator. In this crossover was a butterfly valve operated from the pilot's seat. By opening the valve a large amount of the hot water from the engine would be allowed to pass right back to the water pump again without even passing through the radiator, so that the engine could be kept at almost any desired temperature. This feature has an advantage over shutters as it does not increase the head resistance of the machine. A transmission thermometer, placed in the water line from the engine, gives the temperature at the pilot's instrument board.

The latest radiator installed is of the wing curve, or Albatros type. This radiator was placed between the beams in the upper right hand panel, near the center of the machine, the internal brace wires being moved to the surface of the wing so as not to interfere.

Aerodynamic Features—Model G-2 is very easy on the controls, the slightest touch on the stick being sufficient to change the attitude of the machine. The pilot has pulled out of a nose dive and tailspin with a thumb and two fingers on the stick.

Armament—As noted before, the front part of the body, from the engine to the rear of the gunner's cockpit, is armored with 1/32 in. armor plate (Figs. 3 and 4), thus giving protection to pilot, gunner and fuel tanks from shrapnel, and near-spent machine gun bullets.

Four Marlin fixed guns are mounted near the engine (Fig. 6), one on each side and two above it, and are synchronized to fire through the airscrew. Either the upper or lower pair may be fired or all four fired together. These guns are easily removed by pulling out two pins each (Fig. 6). Note the empty cartridge chute (Fig. 6), from the upper left hand gun, to carry used shells clear of the machine. The fixed guns are controlled by the pilot with a double trigger on the instrument board.

In the gunner's cockpit is installed a piano stool seat enabling the gunner to turn in any direction. Should the machine be pursued from the rear and below the gunner merely steps on a small push button in the floor, and the piano stool drops to the floor so that the gunner can kneel down and fire the lower gun through the hole cut in the bottom of the body (Fig. 4). The angles of fire for the two Browning machine guns on the flexible gun mount are given in Fig. 5 and various positions are shown in the other figures.

All metal parts throughout the entire machine are bonded together with small copper wires so that the whole can be used for a wireless ground.

While originally designed as a war machine, the Model G-2 can be easily converted into a peace machine of great weight carrying capacity. In this event the pilot would occupy the rear cockpit and the front cockpit would be converted into a cargo hold. This arrangement would give a cargo capacity of over 1000 lb. or equal to that of a half-ton truck.

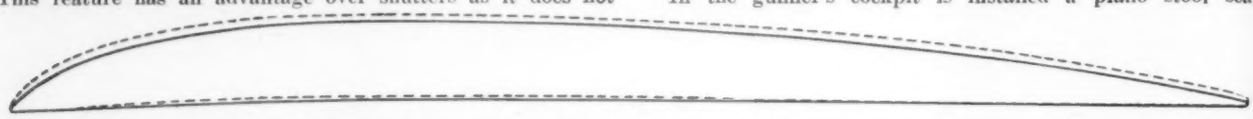


FIG. 7. L.W.F. WING CURVE NO. 1, WITH R.A.F. 6 SUPERIMPOSED (DOTTED)

Organizing for Aircraft Production

By Archibald Black

Factory organization varies greatly in all branches of industry and even among plants turning out similar products. While plants can be operated successfully with wide differences in the organization of their personnel, there is no doubt that a careful arranging of the force—holding in mind both the calibre of the men available and the adaption of the organization to the work—is of incalculable value in preventing the overlapping of authority, locating responsibility where it belongs and generally facilitating the operation of the plant to the best advantage. This is common knowledge to all live executives and is no less true of the aircraft factory than of any other plant, yet here and there a plant is found operating, as best it can, in a condition bordering on anarchy for want of a properly fitted organization.

Probably this is largely due to the fact that the aircraft industry in this country was, until very recently, a "small shop" business. War conditions have changed this almost overnight. Factories which employed fifty men a year ago have thousands on their payrolls today. Men drilled only in small shop methods and word of mouth instructions have been "skyrocketed" into positions of great responsibility calling for keen insight into the problems of quantity production—quantities beyond their dreams of yesterday.

Instead of *building* airplanes they are called upon to *manufacture* them. Any cabinet-maker can build an aileron—it takes a shop organizer to produce ten thousand of them. Hand work and foot rules must be replaced by jigs and fixtures. As a result, the industry is undergoing a period of transformation—probably the biggest of the many reasons for lagging production.

Realizing the importance of a knowledge of the entire field, although my own work is at present confined to the engineering end, I have made it my business to study the organization of the largest aircraft factories as well as that of the most successful plants in the automobile, motor boat and other fields.

The plants studied in the past few years included practically every airplane factory in the United States between Dayton and the Atlantic seaboard, as well as several airplane motor factories and many engaged in other lines, such as the plants of the Ford Motor Company at Detroit, the Packard Motor Car Company at Detroit, the Union Metallic Cartridge Company at Bridgeport, the Electric Boat Company at Bayonne, the National Cash Register Company at Dayton and many others of equal standing.

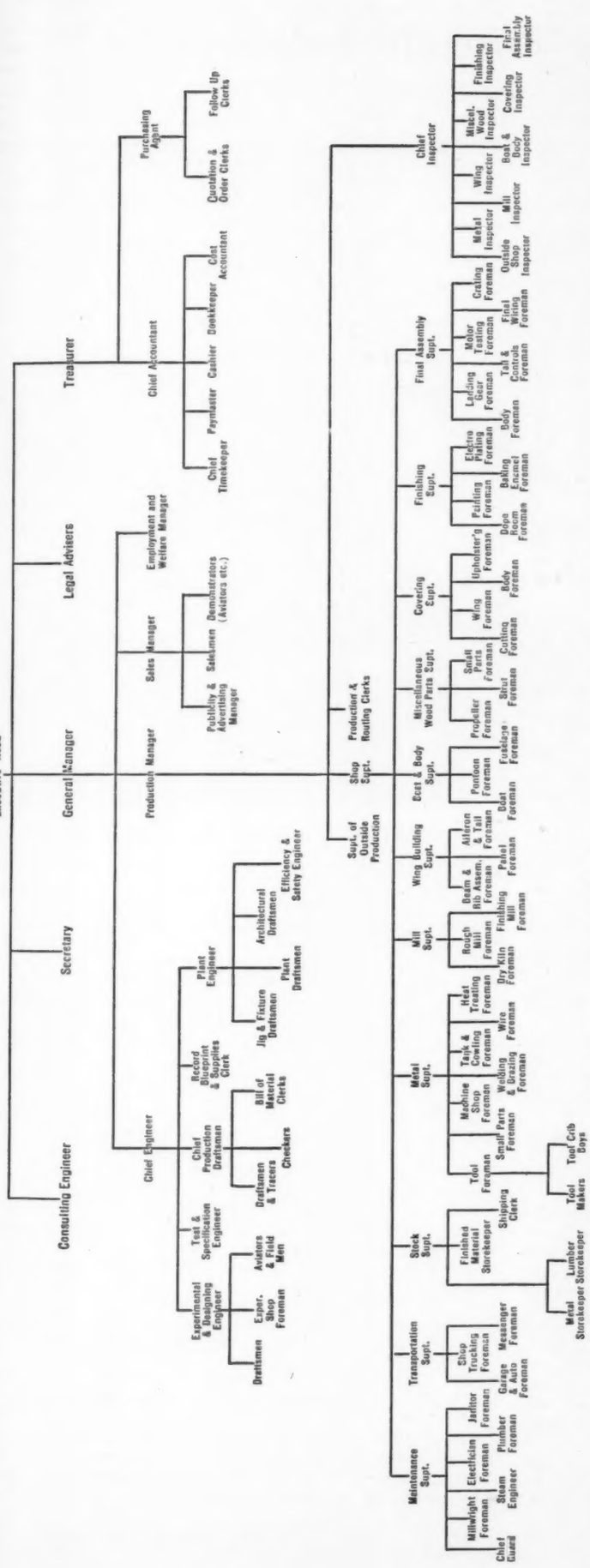
The outcome of this study combined with personal experience has been a more or less definite knowledge of just what form of organization is best adapted to airplane production and the ideas collected or developed are incorporated in the organization diagram given herewith.

This diagram is slightly different from that of any American airplane factory. The most workable features of existing organization have been incorporated and combined and, while it is important to consider the particular abilities of the men available, this form of organization should prove to be a good sound foundation for the operation of any aircraft plant.

The departments are arranged in the diagram to read from right to left in approximately the order in which the work is handled by each.

The designs originate and are developed in the Experimental Division of the Engineering Department, passing to the Production Drafting Room, to the Plant Engineer, and thence into the hands of the Production Manager, through the various divisions of the shop, to the Final Assembly Division, which crates for shipment. It will be noted from the diagram that it is proposed to place in the hands of the general manager all executive control of design, production and disposition of product. In order to give the treasurer direct control of the financial reins, all departments concerned with the disbursing of funds are placed under his sole authority.

The chief engineer is given control of all engineering work. It will be noted that this includes control of all field testing of machines—a condition not always existing in present plants, although absolutely essential to the proper handling of this end of the work. (The demonstrating of machines is placed under control of the sales department).



The placing of the plant engineer under the chief engineer may be considered a debatable point as, in many well organized plants, he takes instructions from the production manager. It appears to the writer personally, however, to possess considerable advantage as shown, in that it brings this end of the work more closely into touch with the development end, and at the same time centers all technical work under the one head.

It will be noted that the chief inspector takes authority from the production manager and not from the shop superintendent. This arrangement should decrease the possibility of any sub-standard work being passed as O. K. in order to keep up the shop schedule. As a matter of fact, in some plants the chief inspector takes authority from the chief engineer; an arrangement which, although good, is probably not quite so satisfactory as the one shown.

The placing of "crating for shipment" under the Final Assembly Superintendent may be questioned, but it should be kept in mind that this operation (1) usually includes the dismantling of parts of the machine, (2) is done at one end of the Final Assembly shop, and (3) is closely related to the other work of this department.

The divisions of the various departments should be of considerable help to others in this industry, particularly to new comers, as they are based on intimate personal knowledge of the working conditions and organization in many aircraft plants as well as a study of such plants as those referred to previously.

This organization is actually much simpler than it may appear at the first glance—the diagram going into considerable detail may suggest intricacy to some. It has been presumed that the shop under consideration employs at least several hundred men, but even in case of smaller plants, the diagram given should be valuable as a guide.

Aircraft Directed by Telephone

Squadrons of American airplanes fighting in France up to the moment of the armistice were maneuvering under the vocal orders of the squadron commander that reached each pilot by radio telephone.

News of the successful development of this device, hitherto a military secret, though some inkling of it had reached the Germans just before hostilities ceased, was allowed to become public Nov. 15 by John D. Ryan, director of aircraft production.

"There are some details concerning it which we cannot discuss yet," Mr. Ryan said, "but the radio devices worked out during months of experiment went into actual service some weeks ago. I have myself, standing on the ground, given orders to a squadron flying in the air and watched them maneuver accordingly. The transmission of the voice is clear enough to be heard distinctly through the sound of the airplane motor. It is in every way the most satisfactory means of communicating between planes in the air and from the ground to planes."

Mr. Ryan said he could not discuss the distances over which the radio telephone has worked, but it is known to be a matter of some miles.

W. C. Potter, of the equipment division of the bureau, explained that the idea of radio telephone was conceived some time ago by a number of experimenters. Its successful development and application to airplane equipment was, however, the work of the bureau's own people.

"For some months it has been possible in our offices in Washington to hear the airplanes flying miles over the city," he said, "talking to each other and to the ground as they worked out and perfected the device."

Col. Clarence C. Culver, of the Air Service, is the man who has led the work of perfecting the wireless telephone and who is credited by scientists with the major part of the credit for its success.

Future of the Aircraft Industry

By Harry Bowers Mingle
President, Standard Aircraft Corporation

In giving consideration to the future of the aircraft industry, considerable thought must be expended in order to retain the picture within its proper limits of perspective, for while it is certain that the progress of the aircraft industry will be very rapid and will reach into fields hereto unknown or unsuspected, it is reasonable to state that those developments will be along sensible lines.

The possibilities of airplanes of large size and enormous horsepower are certain, but to be immediately realized they depend largely upon the ability of the district in which they are to be used, to properly provide for their housing and landing.

THE FIRST MACHINE-BUILT HANDLEY-PAGE OF THE STANDARD AIRCRAFT CORP.

Pausing to realize that airplanes must necessarily have their places to land, it would seem that now is the time for all of the states and civic sub-divisions of states to turn their attention to the possibility of establishing landing fields within the districts of proper size and convenient to points along the direct routes which are to be established between the principal cities.

As these landing fields and routes are established and developed, the types of airplane which will be used to maintain connections between them will be correspondingly advanced. The universal service of the airplane will be accompanied by an increased demand for types of planes of a purely commercial design and the manufacturers will be able to keep pace with this demand.

Ten years is a long time in which to make the prediction of the development of the aircraft industry and in order to hold the correct estimate of our future, it would be extremely unwise to diagram the years to come that far in advance. It would be more consistent with our present progress to limit our prediction to the next twelve months during which time the industry will have readjusted itself to the peace time conditions and will be, at that time, in a position to take up the commercial requirements as the urgent needs indicate as being desirable and essential.

With the suspension of hostilities, aircraft manufacturers who had established their enterprises solely for the purpose of meeting the military requirements during the war period are viewing with grave consideration their future prospects. Their experience as manufacturers of aircraft on a wartime program will not be of much use to them in the manufacture and sale of commercial airplanes and when entering the open market on a competitive basis.

They are handicapped by the fact that their designs are of a purely military type; that the process of manufacturing is on a scale far in excess of the needs of the commercial types of machines for sometime to come; that the experience they have acquired in the development of the military types cannot be used to the same advantage in the commercial fields. The staff and personnel will not be able to meet the new conditions with the same facility as when they entered the field during the war. The experience they have acquired is entirely different from aircraft experience which goes with a peace time program and to readjust their minds to this new condition will set them back just so long as the period of learning now continues.

As a consequence of these limitations, the development of the commercial airplane and the manufacture of aircraft for purely peace time uses will be undertaken only by a limited number of the airplane manufacturers. Among the few who will survive the period of readjustment will be those who have enjoyed a pre-war experience and who are now more than ever fully capable of meeting the new demands of the future.

The Standard Aircraft Corporation with its plant at Elizabeth, New Jersey, will be one of the plants to continue its activities after the war. This company will return to its original pre-war plans, those having been laid aside temporarily to enable the company to participate in the military and naval requirements. The "Standard" will continue in the manufacture of aircraft of all types and will create special designs to meet the new requirements. They will keep well in advance of the trend of progress which has characterized its efforts throughout its history. This company has made rapid strides during the war and this, coupled with its pre-war experience, will enable it to gain and maintain a position in the newest industry well up in the front ranks. Their efforts will help to firmly establish the airplane as a means of transportation and an important element of public utility.

Possible Uses of the Airplane

In contemplating the uses to which airplanes may be utilized to an advantage the possibilities are:

(1) *Policing the Air.* Airplanes of a special design combining the elements of speed, mobility, sturdiness of construction, high ceiling, and low landing speed. This type must be absolutely dependable for the special uses to which it will be placed, that is, to maintain a proper regulation of the traffic of the air highways.

(2) *Coast Patrol and Navy Service.* In order to maintain contact between the authorities who have jurisdiction over the aerial highways over land, the naval authorities will extend their service to a system of patroling the sea coast and will extend the service to cover the inland waterways, the Great Lakes and the Panama Canal. For this service a type of flying boat will be needed to meet the peculiar requirements. This will be a modification of the type which is now in use, so that the aviators will have adequate protection against exposure to the weather. With this will also be developed a

type of airplane that will be used by the Internal Revenue officers to properly maintain the regulations of that department in rivers and harbors.

(3) *Military Purposes.* The activities of the Army in the maintenance of the military establishment during peace times will require the use of airplanes as a means of maintaining contact between the various military districts and administrative centers. With this will also be given consideration to the transportation of personnel for emergency service, also to participate in the regulation of the air traffic and to apply the rules for landing on fields and water so that landings, forced or otherwise, may be properly provided for and regulated.

(4) *Express Service.* In this service, a type of aircraft will be developed that will carry two thousand pounds, or more, of valuable registered express packages. These express planes will operate between large cities and will ultimately reach a continuous service between the extreme east and west coasts.

(5) *North and South Travel.* There will be established a line of communication between the north and south in more direct routes than are now in operation, which will do much to convey to the trunk lines of railroads the necessity for further development of branch lines.

(6) *Post Office and Mail Routes.* The pioneer work of the Post Office Department in establishing aerial mail service will be of uncalculable benefit to the commercial development of the country in the further expansion of this service. It is reasonable to predict that every city of importance will have a mail service that will be frequent and dependable by means of the Post Office planes.

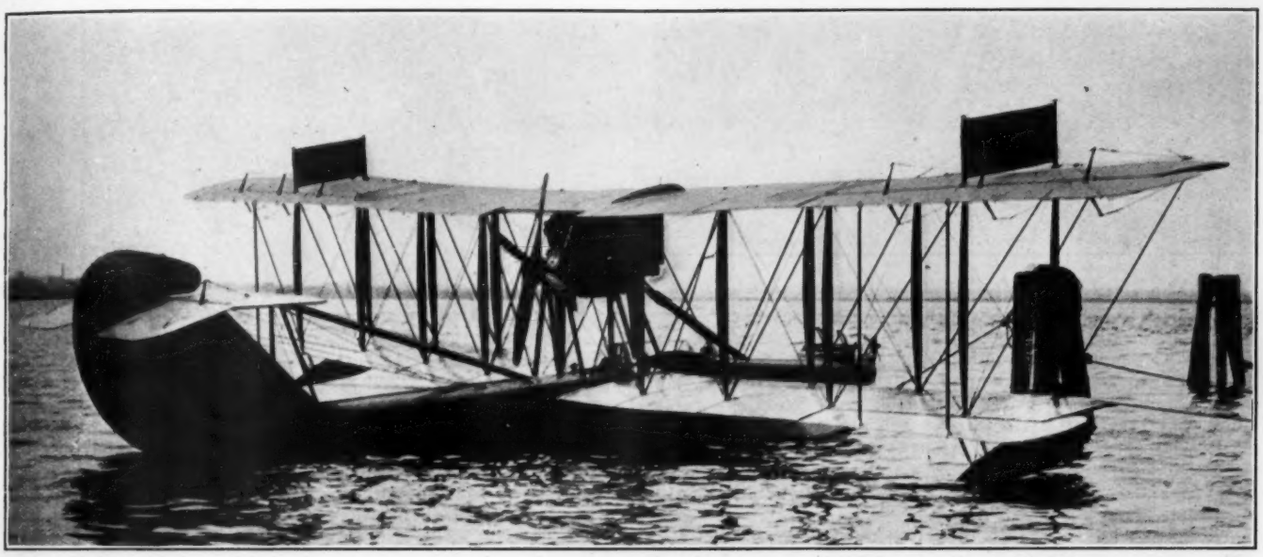
Outlying towns and districts which are not now frequently served will have the advantage of contact with the larger commercial centers.

In order to meet the many and varied requirements of the Post Office Department, the activities of the manufacturers will undoubtedly be directed to the development of four different types of airplanes, each one fulfilling a definite requirement of the service.

(7) *Fast Passenger Service.* At first a small number of people will avail themselves of the opportunity to cover long distances in a short length of time and as the certainty of the service becomes apparent, and where the time is limited and the occasion urgent, business men will be glad to avail themselves of the opportunity of the aerial passenger routes. A type of plane not now in operation will be developed to meet the requirements of this particular service.

(8) *Trans-Atlantic Flight.* Serious development will take place in the organization of trans-Atlantic airplane service to an extent that will make it one of the most important adjuncts to the commercial development of the world. The types of machines which will be used in this service will be a further development of the Handley Page and the flying boat types and will be probably a combination of these two. It remains, however, for the more widely experienced manufacturers and designers to carefully go into the development of this particular type of plane, as it involves many considerations which need to be refined to a degree that will make trans-Atlantic flying a commercial proposition. But the time for this class of service is also at hand.

(9) *South America.* The allurement of the possibility of the development of both civil and military air service in South America will cause many companies to spend considerable time, money and effort to make a big profit. In looking at this dream of immediate success, there must be considerable thought paid to the limitations of the countries in which the airplane is to be used.



THE HS-2L NAVAL FLYING BOAT BUILT BY THE STANDARD AIRCRAFT CORP.

While the opportunity is undoubtedly present for a development that will be extremely profitable, we believe that the markets at home should be more fully developed before making the attempt to enter into foreign fields.

(10) *Alaska.* The great riches of the Alaskan district have not been fully brought to light by reason of the fact that railroads cannot be built except at the cost of untold effort and extending over a long period of time. The possibilities of establishing and maintaining a system of airplane routes throughout the Alaskan district is immediately before us. Without being required to make any extraordinary changes in the present types of planes, it is reasonable there can be released to this service a sufficient number of aircraft that will produce a prompt return on a relatively small investment. This perhaps is one of the most advantageous opportunities for commercial development that this country can offer.

(11) *Mapping.* The United States Geodetic Survey and similar departments will be able to utilize the service of the experienced aviators and the military types of photographic machines without changes for the purpose of securing a complete photographic record of the topography of the United States and its surrounding coast lines. This is a service that can be started at once and be continued as a part of the military program.

(12) *Agriculture Department.* The Department of Agriculture will have the advantage of the use of airplanes in the investigation of the possibility of developing certain parts of the country by irrigation which have heretofore been out of reach because of the great risk and difficulty in gaining access thereto. This will open to those ambitious to become farmers a new country of great richness.

(13) *Forestry.* The Department of Forestry will be placed in a position to give a more efficient service by reason of maintaining an airplane patrol service over the forested areas; it will also be able to make accurate maps of districts which have not been penetrated, releasing to the commercial markets stands of timber which contain the finest of materials.

(14) *Exploration.* The value of airplanes in bringing to a closer view the territories of this country and other countries which have heretofore not been fully explored is apparent. The educational value of the information obtained through

this medium will be of a high order and the number of specimens that will indicate the true aspect of the district in all its phases will be sufficiently large to present a complete picture of territory hitherto unknown.

(15) *Sporting Types of Airplanes.* Sportsmen will interest themselves keenly in the use of airplanes for conveying them to the various points throughout the country where they will have the opportunity to display their skill and exercise their desire for adventure. Aircraft will be used in every conceivable form for the satisfaction of the sportsman instinct, in all its phases. Airplanes of various types will be designed and constructed to meet their requirements. Many of them will be of a standardized type; others will be made to suit the individual tastes of the owner.

Altogether, advantage should be taken of the opportunity offered to satisfy the sportsman's demands; there should be included in a well balanced organization a number of sporting types of aircraft and these should be designed especially for that purpose.

This briefly outlines the uses to which an airplane may be put. But there is something new, and that is the opportunity of America to place itself in a position of absolute supremacy through the development of the air service, the value of which will become more apparent as time goes on.

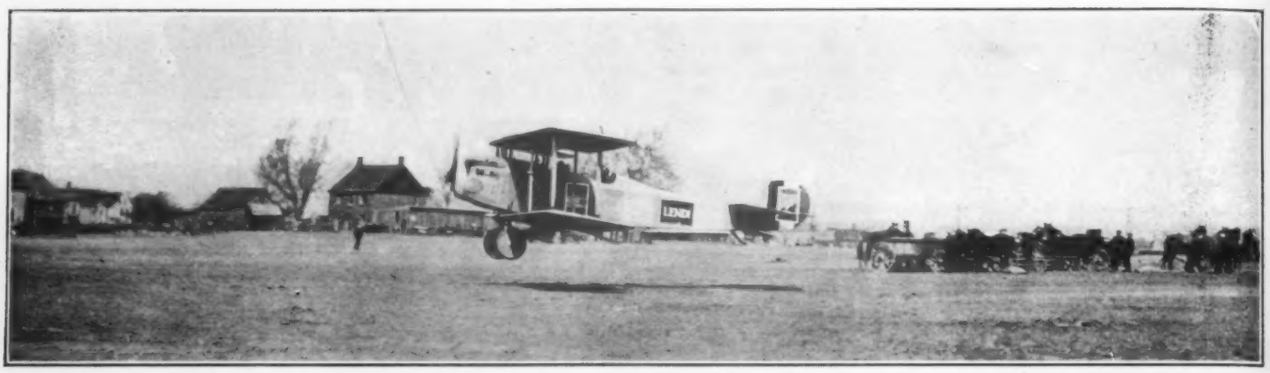
Government Support Needed

To establish the pioneer enterprise in the different classes of service which are under discussion, is the work which must be done at this time. It is reasonable that the initial efforts of the aircraft manufacturers should not be allowed to resolve themselves into inaction and that interest in aircraft must be continued under a strong stimulus.

That the government will continue to fire their encouragement to the commercial development of aeronautics to the same extent as it has the military and naval needs during the war is regarded as being of primary importance.

The operation of civil aerial transportation services is entirely different from that of a railroad, motor truck or steamship service and on account of the peculiar conditions of operation of the newer enterprises, governmental support is both essential and desirable.

We all look forward to the time when the demands for commercial aircraft will be great enough to maintain a thriving industry, and it is recognized that before this is an accomplished fact many months will have passed, each filled with new experiences and hopes.



STANDARD-BUILT MAILPLANE FITTED WITH A 150-HP. HISPANO-SUIZA ENGINE TAKING OFF

The pioneer manufacturers during this period will have the advantage of their early experience, but they must have substantial stimulant to their efforts. This the Government could supply through its military, naval and civil channels.

It is not contemplated that vast appropriations of money will be placed at the manufacturers disposal as during war times, but it is reasonable to assume that each of the three branches of the Government will find that certain types of aircraft are needed to meet their particular requirements and these types must be especially designed, constructed and put into service with that object in view.

In attaining this objective, it is of importance that the Government should be as generous as it is consistent with economic science. One of the gravest misfortunes of many of our industries in other lines has been the retardation of effort due to a lack of substantial support or a limited market. In the aircraft industry, until such day when the limited market will have become expanded to a more universal scope, the Government should lend it support in every possible direction.

Among the many new things which will be needed to regulate the development of the commercial airplane is the question of federal legislation to provide for the proper licensing of pilots and aircraft.

It will also be necessary to provide for the establishment and maintenance of certain zones and roads of travel in order to prevent confusion in the air traffic, and the laws which will regulate this traffic should be made with a view of giving the fullest consideration to the commercial development and needs. Because of the intangible territorial jurisdiction of the States and the civic sub-divisions within the States, it is reasonable that these laws should be administered by the military and naval authorities rather than by the civil authorities, it being impracticable to clearly define the limits of control as is customary with highways, railroad and similar public utilities.

Book Reviews

AEROPLANES AND AERO-ENGINES. By "Avion." (J. B. Lippincott Co., Philadelphia. Price, $1.00. 158 pp. Illustrated.)

This short handbook has been written in simple, non-technical language to furnish an elementary introduction to the problems of flight for persons not technically interested in aviation. Though its language is as simple as possible, and the various aspects of flying are treated in what may seem to the aeronautical engineer a superficial way, this little book really fulfills most excellently its purpose, that of conveying to the totally uninitiated a working knowledge of aviation. That large section of the public whose interest begins to be aroused by the prospects of air transport, not to speak of aeronautic reporters on the staff of daily papers, will find it worth their while to consult this little book.

SIMPLIFIED NAVIGATION FOR SHIPS AND AIRCRAFT. By Chas. Lane Poor. (The Century Co., New York. Price, $1.50. 126 pp. Illustrated.)

Written in a simple, readable manner, this book of handy pocket size explains the modern method of navigating ships and aircraft, which is known by the name of its originator, Admiral St. Hilaire, and is now used almost exclusively by the vessels of the United States Navy.

The entire book is really devoted to the one subject of how to find one's position at sea or in the air, and this is very comprehensively treated from viewpoint of the practical navigator and airman, whose one aim is, of course, to find his position in the shortest time and with the least amount of figuring. The necessary charts, diagrams and tables are included in the text.

Performance and Cost of the Air Mail Service

Second Assistant Postmaster Otto Praeger has issued reports on the performance of the Air Mail Service during the month of October and on the cost of operation and maintenance during September. These reports are printed herewith.

It should be noted that in the tables of operation and maintenance the airplanes numbered 1-6 are Standard-Hispano machines, while the series 38 and 39 are Curtiss-Hispano, and Curtiss-Liberty airplanes, respectively.

A comparison of the accompanying report of operation and maintenance with that issued for the month of August—which was published in the Nov. 1, 1918, issue of AVIATION AND AERONAUTICAL ENGINEERING—shows that the Post Office Department continues to better its record of efficiency in operating the Air Mail Service. While the total cost of the service shows a slight increase, $9,638.74 as against $9,555.67 for August, this is obviously due to initial expenditure involved in organizing a new air mail route, from New York to Chicago, an item also reflected in the cost per hour of operation, which was $47.90 in September, as against $47.06 in August.

Considering the above item as well as the atmospheric conditions arising from the advent of autumn, the showing made in September appears particularly good. Cost of repairs and accessories has dropped from $1,320.46, in August, to $910.02, and the total of gallons of gasoline consumed shows a reduction from 3,510, in August, to 3,443, although the total flight-mileage has increased from 15,120 to 15,263, and the cost per flight-mile has been reduced from $0.6319, in August, to $0.6315. On the other hand a better showing has been made in gallon-miles, the average for September being 4.43 as against 4.30 for August.

The postal fleet has been further increased by the addition of a new airplane; a number of postal airplanes destined for the New York-Chicago route is now building and nearing completion. The Post Office Department proposes to inaugurate this route during the first fortnight of December.

SERVICE AND UNIT COST, SEPTEMBER, 1918

Airplane No.	Gallons of Gas.	Total Time Run. Hr.	Min.	Total Miles Run.	Miles per Gal. of Gas.	Cost per Hr.	Cost per Mile.
1	648	39	29	3,243	5.00	$29.35	$0.3573
2	247	20	20	1,327	5.37	33.21	.5089
3	250	14	39	1,254	5.01	54.07	.6317
4	376	27	47	2,111	5.61	35.52	.4675
5	296	17	22	1,306	4.41	44.47	.5912
6	110	4	09	270	2.45	165.89	2.5498
38262	215	22	30	1,542	7.17	32.35	.4720
38274	261	14	53	976	3.73	47.12	.7185
38275	137	7	42	623	4.54	64.94	.8026
38278	159	11	05	741	4.66	55.16	.8250
39362	25	1	35	90	3.60	221.92	3.9042
39363	25	..	53	90	3.60	389.76	3.8254
39364	45	..	..	..	...	.....	.....
39365	149	1	48	190	1.27	254.43	2.4104
39367	500	17	00	1,500	3.00	33.47	.3793
Total...	3,443	201	12	15,263	4.43	$47.90	$0.6315
Cost of N. Y.-Chic. route, exploitation	791	46	31	3,510	4.43	$47.66	.6315
Cost of N. Y.-Washington route	2,652	154	41	11,753	4.43	$47.98	.6315

AIR MAIL PERFORMANCE, OCTOBER, 1918

Date, 1918. October.	Miles Flown. 1.	Hours of Flying. Hrs.	Min. 2.	Mail Carried A. 3.	O. 3.	Per Cent of Performance, %. 4.	Arrival. Wash. 5.	N. Y. 5.
1	436	5	04	34	593	100	2.38	2.23
2	436	6	14	32½	602	100	4.28	2.00
3	436	5	39	35½	578	100	3.21	2.25
4	436	6	01	30½	609	100	3.51	2.38
5	436	5	59	30	590	100	4.13	2.05
7	436	5	50	29½	489	100	2.21	3.28
8	436	5	36	34½	574	100	2.44	3.00
9	436	5	30	33½	562	100	2.49	2.33
10	654	8	19	33	886	100	2.43	2.35
11	654	9	46	34	852	100	4.20	2.12
12	436	6	53	28¾	564½	100	5.15	2.03
14	436	5	46	45½	601	100	3.03	2.40
15	466	6	22	30½	608	100	3.28	3.30
16	436	6	26	27½	243	100	3.49	2.57
17	436	6	16	32½	600	100	4.07	2.12
18	520	6	35	31	770	100	2.45	3.12
19	436	5	29	34½	574	100	2.43	3.45
21	436	5	58	35	518	100	3.47	3.05
22	436	5	51	35	556½	100	3.15	3.15
23	436	5	22	40	507	100	3.33	2.56
24	436	5	59	33	499	100	4.12	2.25
25	436	5	39	30½	526	100	3.26	2.10
26	436	5	50	33	522½	100	3.34	4.05
28	436	5	29	38	593	100	3.43	2.08
29	436	5	48	53½	598	100	4.13	2.23
30	281	2	04	35½	713	50	*	2.35
31	436	5	50	49	520	100	4.00	2.04
Total..	12,167	161	35	939¾	15,848½	...	...	...

* Forced landing. Mail sent in by train.

Note.—Number of hours dead flying for the month, 10 hrs. 36 min.

Explanation of Tabulation:

1. *Miles flown:*
   Leg from Washington to Philadelphia.....128 miles
   Leg from Philadelphia to New York..... 90 miles

Miles flown for the day, whether one, two, three or four legs of the trip have been made.

The aim is to get exactly the number of miles flown in connection with the mail service each day. Therefore, mileage of partial trips should be indicated.

2. *Hours of flying:* To include the actual hours and minutes machine is in the air with mail.

3. *Mail carried:* In this column, under A, give pounds of airplane mail; and under O, give pounds of ordinary mail.

4. *Per Cent of Performance:* Round trip Washington-New York consists of four legs, each leg valued at 25 per cent if completed by airplane and not by train before close of day.

PERFORMANCE OF AVIATORS, OCTOBER, 1918

Total possible number of flights	108
Total possible mileage	11,772
Total perfect (uninterrupted) flights made	105
Total interrupted flights made	2
Total flights defaulted on account of weather	0

Pilot.	Perfect Flights. No.	Miles.	Forced Landings. Interrupted Flights.	Uncompleted Flights.	Total Flights. No.	Miles.
Dana C. DeHart	30	3,270	0	0	30	3,270
Maurice A. Newton	25	2,744	1	1	27	2,897
Robert F. Shank	26	2,834	0	0	26	2,834
Max Miller	24	2,616	0	0	24	2,616
Total	105	11,336	1	1	107	11,617

COST OF OPERATION AND MAINTENANCE, SEPTEMBER, 1918

Airplane No.	Gas.	Grease and Oil.	Office Force.	Rent, Light, Fuel, Motor-cycles, Trucks.	Power, Telephone and Water.	Misc.	Pilots Actual Time.	Hangar Men. On Plane.	Misc.	Mechanics. On Plane.	Shop Time.	Repairs and Accessories.	Interest on Investment.	Departmental Overhead Charge.	Total.
1	$177.34	$15.96	$23.98	$31.52	$21.50	$47.80	$306.10	$17.76	$3.07	$75.88	$17.95	$266.32	$74.79	$78.95	$1,158.92
2	75.62	18.34	23.98	31.51	21.50	47.80	157.65	20.25	3.07	100.92	17.94	3.06	74.79	78.95	675.38
3	66.85	29.20	23.98	31.51	21.50	47.80	113.60	20.86	3.07	144.09	17.94	118.04	74.79	78.95	792.18
4	114.55	33.46	23.98	31.51	21.50	47.80	215.40	20.86	3.07	113.42	17.94	189.74	74.79	78.95	986.97
5	88.45	23.49	23.98	31.51	21.50	47.80	134.65	19.31	3.07	138.39	17.94	68.38	74.79	78.95	772.21
6	33.00	9.35	15.65	31.51	21.50	47.81	32.25	18.31	3.07	108.54	17.94	195.80	74.78	78.95	688.46
38262	65.11	26.51	23.98	31.51	21.50	47.81	174.45	23.86	3.06	130.41	17.94	8.04	74.78	78.94	727.90
38274	78.83	21.12	23.98	31.51	21.50	47.81	115.40	20.47	3.06	153.61	17.94	12.33	74.78	78.94	701.28
38275	41.34	9.40	23.98	31.51	21.50	47.81	59.75	18.01	3.06	69.00	17.94	3.04	74.78	78.94	500.06
38278	51.79	15.91	23.98	31.51	21.50	47.81	85.85	17.70	3.06	95.30	17.94	45.27	74.78	78.94	611.34
39362	7.50	1.62	15.66	31.51	21.50	47.81	12.30	16.76	3.06	22.00	17.94	....	74.78	78.94	351.38
39363	7.50	....	15.66	31.51	21.49	47.81	6.85	16.75	3.06	22.00	17.94	....	74.78	78.94	344.29
39364	13.50	1.10	6.77	31.51	21.49	47.81	....	4.42	3.06	....	17.94	....	74.78	78.94	301.32
39365	44.70	1.10	6.77	31.51	21.49	47.81	13.95	4.41	3.06	111.53	17.94	....	74.78	78.94	457.99
39367	140.00	.50	6.77	31.51	21.49	47.81	131.80	4.41	3.06	10.05	17.94	....	74.78	78.94	569.06
Total..	$1,006.08	$207.06	$283.20	$472.66	$322.46	$717.10	$1,560.00	$244.14	$45.86	$1,295.14	$269.11	$910.02	$1,121.75	$1,184.16	$9,638.74
Cost of N. Y.-Chic. route exploitation	$231.40	$47.62	$65.14	$108.71	$47.17	$164.93	$358.80	$56.15	$10.55	$297.88	$61.89	$209.30	$258.00	$272.36	$2,216.91
Cost of N. Y.-Wash. route....	$774.68	$159.44	$218.06	$363.95	$248.29	$552.17	$1,201.20	$187.99	$35.31	$997.26	$207.22	$700.72	$863.75	$911.80	$7,421.83

The Proper Function of the Elevator

By A. A. Merrill*

In every flying machine the elevator has two functions, namely, to control the angle of inclination and to fix the angle of incidence. I shall differentiate between these two functions as follows:

1. To control the angle of inclination—It is desirable, in flying, that gusts which alter the angle of incidence shall not alter the angle of inclination. The elevator introduces a couple which can be made to balance any couple produced by gusts. This is the proper function of the elevator.

2. To fix the angle of incidence—Let us suppose that we have before us a side elevation of a model which has been tested and which shows the vectors for all flying angles, the pitching moment graph, the L and the L/D graphs. From this we find that the angle at which L/D is a maximum is, say, 3 deg., and that at this angle the tail and elevator are neutral to the air stream. Suppose V is 100 m.p.h. with a loading of X pounds per sq. ft. To get the best performance we know we must place the c.g. on the vector for 3 deg., assuming the thrust passes through the c.g. If we do this the machine can fly only at 3 deg. without using the elevator.

There are, however, three conditions which may cause us to fly for long periods of time at an angle other than 3 deg. These conditions are climbing, diving and horizontal flight at more or less than 100 m.p.h. To do this we must bring the elevator into play and hold it in operation. This is what I call fixing the angle of incidence, and, in my opinion, it is no proper function for the elevator or for any other surface.

In the first place, the pitching graph obtained from the model shows the elevator always in one position relative to the longitudinal axis. The stability of the model, which determines the safety of the machine, is based upon the assumption that the elevator bears a constant angular relation to the other surfaces. As a matter-of-fact, this is not so. To decrease the angle of incidence the elevator is turned down, but this destroys immediately the aerodynamical characteristics of the model. Tests made by Eiffel and by the N. P. L. show conclusively that going into a dive by means of the elevator may destroy entirely the righting pitching couple and produce static instability.

A very good description of the danger thus produced is given in "Aeronautics in Theory and Experiment," by Cowley and Levy, pages 252-3-4. Practically this means that when in a dive static stability may be lost, and the time necessary to get out of this condition by means of the elevator may be so long that without sufficient altitude the machine may crash before it comes out. It is not at all improbable that many of our fatal accidents in training are due to this characteristic of our machines. Of course, a well-trained man will sense this danger early enough; nevertheless, no machine should be built which will ever have to fly in a condition of instability in pitch. This dangerous condition is even worse than the graph shows, because the elevator, which has to be used to get out of this condition, is away from its neutral position, so that for a given angular movement its change in K_y is much less than it would be if it started from neutral. The same fault exists when we raise the elevator for landing. The stiffness of the machine is increased, and there is also loss of control by the elevator, both faults appearing just when we most need ease of control. In my opinion, the fixation of the angle of incidence is not a proper function of the elevator.

The alternative I suggest is moving the c.g. This may appear a radical departure, but it is not nearly as radical as was flight itself in 1903. The mechanical details of such a design do not appear to me insoluble. One method would be to have the biplane structure a complete unit by itself, designed to take all strains by its own internal bracing. The body and undercarriage would be another complete unit. The planes would be fastened to the body so as to admit sliding motion fore and aft, possibly in steel channels. The two would be connected by an oil cylinder and piston. In the cockpit there would be a three-way valve controlled by a lever at the right of the aviator. Outside the body, in front, there might be a small pump driven by an airscrew similar to the radio generator set now in common use, or the pump could be connected direct to the engine. While flying this pump will always be working, but with the lever neutral the oil will pass the cylinder through a bypass. When it is desired to dive, both the stick and the valve lever are pushed forward. The elevator immediately puts the machine into the dive, but as the c.g. moves forward the elevator is released, the dive being maintained by the new position of the c.g. Static stability is at once regained and the elevator is back at its neutral position, where it has its maximum power to control the angle of inclination, which latter is its only proper function. A mechanical alternative is to connect the three-way valve directly to the control stick. This is a simple engineering problem, the solution of which will eradicate a very serious danger.

Attention is called to the fact that only for quick stunt work will the use of the elevator be necessary. For all commercial flying, fixation of the angle of incidence will be done entirely by moving the c.g., because with this kind of flying the time lag is of little importance. Under these conditions the machine will always give its best L/D ratio, since the elevator will add no drag and, best of all, the machine will always have its predetermined static couple, and the elevator will always rest neutral, where it can produce its maximum controlling couple.

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Petroleum Situation

In view of the growing importance of gasoline and fuel oil in carrying on the industrial and military activities of the United States and its Allies, a comprehensive survey of the petroleum situation will meet a widespread interest. The United States National Museum, Smithsonian Institution, has just issued a 74 page bulletin on this subject, entitled "Petroleum: A Resource Interpretation," by Chester G. Gilbert and Joseph E. Pogue of the Division of Mineral Technology. This bulletin, which is freely illustrated with photographs and diagrams, gives a rounded view not only of the petroleum resource, but of the petroleum industry by means of which petroleum products are brought into use.

The rapid exhaustion of the unmined supply of petroleum, the war needs for petroleum products, and the national importance of maintaining into the future an ample supply of motor fuel, are weighed against the limited nature of the resource and the wastes inherent in its present type of exploitation, and a plan is suggested whereby this vital resource may be conserved by full utilization, with a gain in the service that petroleum may be made to yield. The subject matter is presented in a readable, non-technical form, and is designed to enlist the interest of the public in one of the important resource problems of the day.

Mineral resources are coming more and more into prominence as the basis upon which modern advance is built. Their adequate development is a matter of the first importance, and public opinion will be called upon in increasing measure to shape the course of advance in this fundamental field. Petroleum is of peculiar value to society because it is the sole source of gasoline, the dominant motor fuel; provides kerosene, the most important illuminant outside of cities; and yields lubricating oil, upon which the wheels of industry revolve. In addition, it has come to be an essential fuel in the far West, where coal is lacking; is requisite to the operations of an oil-burning navy, and forms the starting-point for an oil by-products industry, a branch of chemical manufacture still in its infancy and offering unlimited possibilities of development. In fact, it would not be an exaggeration to say that oil by-products represents one of the foremost industrial opportunities that confront the American nation today.

The petroleum resource stands out because of its limited size and decreasing availability, the growing importance of its products, and the notoriously high percentage of waste involved in its mining. According to conservative estimates, scarcely 10 per cent of the resource value is recovered under present conditions, while the unmined supply now available in the United States is only about 70 barrels to the person. The presence in this country of extensive deposits of oil shale removes the danger of early physical exhaustion in respect to oil, but it does not necessarily insure a deferment of the period of economic exhaustion which is being prematurely rushed into the present by the current wasteful use of the limited petroleum resource.

Corrosion Prevention on Aircraft Metal Parts

By Lieut. H. A. Gardner

Construction Corps, U. S. N. R. F.

Iron and Steel. Steel fittings on seaplanes and airships are often subjected to great stress. If allowed to rust they will become weak and unfit for service. In such condition their continued use might cause serious results. It is imperative, therefore, that all steel fittings, especially steel strength members, be given the best commercial treatment to prevent corrosion. Until recently, aircraft fittings made by contractors have been copper plated. In certain instances these fittings have subsequently been plated with nickel. Some of these fittings were then painted before assembly. It is probable that better results would have been obtained if no plating had been applied, as copper and nickel give only the temporary protection that is afforded by their low solution tension. In order to better understand these conditions, a brief outline of the causes of corrosion is given below:

If two metals are placed in contact in the presence of water, a primary battery is formed, and galvanic action ensues. The electropositive metal will go into solution and the electronegative metal will be unacted upon. This effect may be illustrated by placing a strip of iron in a solution of copper, when it will be found that the iron (electropositive metal in this couple) will go into solution, and the copper (electronegative) will plate out. If a strip of iron is placed in a solution of zinc, no such phenomenon will occur, zinc being electropositive to the iron. If a copper plated fitting becomes scratched or abraded, moisture and air will be admitted. The iron, being the electropositive metal in the galvanic couple that is formed, will rapidly pass into solution. The oxygen of the air will then oxidize this solution and iron rust will be precipitated out, piling up into a spongy mass which will retain moisture that will serve to continue the corrosion.

There is shown below a number of the commonly used metals, in the order of their solution tendencies:

Aluminum.
Zinc.
Iron.
Nickel.
Lead.
Copper.
Tin.
Antimony.

Any metal mentioned above, when placed in contact in the presence of water with another metal lower in the series, will tend to protect the latter metal from corrosion. A study of the above series will indicate that the only commercially available metal applicable as a coating, that is higher in the series than iron, is zinc. This metal is therefore theoretically ideal to use as a protective coating on iron surfaces when applied in the form of galvanizing. The film of zinc produced, even when abraded, will have a marked protective influence upon the adjacent areas of bare steel.

The standard procedure of the Aircraft Division of the Bureau of Construction and Repair, Navy Department, as of Oct. 15, 1918, calls for the treatment of metal parts, such as have in the past been plated with copper or nickel, to be coated with zinc. The zinc applied should be in accordance with Aeronautical Specification C&R No. 39-A, which allows the application of the hot dip method of galvanizing, the vapor method, and the electro-deposition method. There is no preference expressed as to the method used, since it has been found that one is quite as durable as another, provided the suggested weight of zinc (.60 oz. per sq. ft.) is obtained. The preference that is usually expressed for the hot dip galvanizing process has probably come from the fact that this process usually produces a very much heavier coating than the other processes. In the salt spray test, after 100 hours' continuous exposure of metal coated by the three methods, practically the same resistance to corrosion has been shown. It should be remembered, however, that the hot dip or sherardizing processes operate at a high temperature (approximately 375°-475° C.). This temperature may injuriously affect certain types of heat treated steels or alloys, and for this season the zinc plating process (cold galvanizing) is preferred for such work.

Metal parts should be carefully inspected previous to plating, in order to find any defects that the plating would fill up. Subsequent to plating, the metal parts, either before or after assembly as may be decided, are painted with enamel in accordance with Aeronautical Specification, C&R No. 4-A or 5. The purpose of the enamel is to give the metal parts a satisfactory color that will be in harmony with the rest of the craft, and to provide a waterproof film that will afford protection to the zinc and lengthen its effective life. When exposed galvanized parts are not protected with paint, white oxide of zinc will appear on the surface. Removal of this by washing lowers the protective effect. For this reason it is advisable that all forms of galvanized objects exposed to sea water should be coated with varnish or enamel.

In the salt spray test referred to above, zinc coated samples must show no rust after 100 hours' continuous exposure. This test is a comparative one, and it is believed that the results obtained therefrom closely parallel the results obtained from actual exposure over a period of several months. Steel parts that have been coated by phosphoric acid treatment or similar patented processes, or that have been coated with tin or with terne plate, show marked corrosion in the salt spray test in from five to twenty-four hours. In no instance do such treatments compare with properly produced zinc coatings.

Aluminum. Aluminum, on account of its high solution tendency, will corrode rapidly when exposed to the air in the presence of moisture. The corrosion around salt water is of course more rapid than in inland areas. Since aluminum is used quite extensively on aircraft for various purposes, including the construction of gauges, speedometers, inclinometers, Venturi tubes and airship girders, it is important that the metal should be protected. When a clear finish is desired, Spar Varnish in accordance with Aeronautical Specification C&R No. 3-A may be used, with subsequent baking of the metal part when convenient, in order to give a more durable coating. Naval Gray Enamel in accordance with Aeronautical Specification C&R No. 4-A may be used when a colored coating of even greater efficiency than the Spar Varnish is desired. On Venturi tubes it is probable that best results would be obtained by using a well strained, rather thin solution of Spar Varnish, since dipping of the part would be required. The dry film of such a varnish would have a thickness of approximately .0002 in., which is not sufficient to cause any deviation in the readings obtained through the tubes. Plating of aluminum has been proposed, but found unsatisfactory. The plated coatings are non-adherent and porous. Exposure of plated aluminum sheets results in the rapid corrosion of the aluminum, which is manifested by the appearance of white aluminum hydrate oozing through the surface. It is possible, however, that some alloy of aluminum might be developed that would have a low solution tension and thus be more resistant to corrosion and less subject to the above mentioned defects.

The Bureau of Construction and Repair is arranging for a series of exposure tests on commercial aluminum alloy sheets. Some of these will be coated with the materials referred to above and in other fashion. They will be exposed at various points along the coast in comparison with uncoated specimens.

700 Mile Record Flight

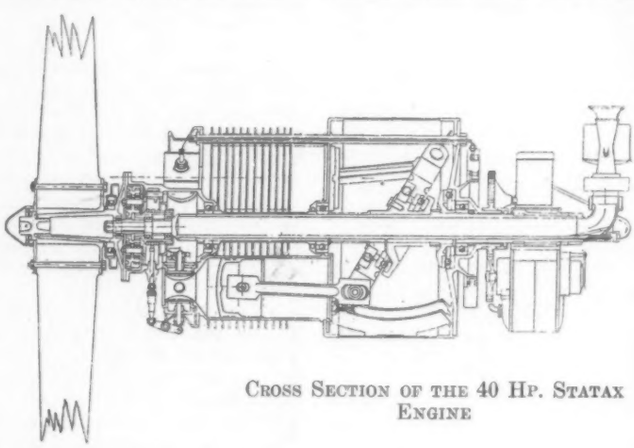
A DeHaviland airplane, fitted with a 400 hp. Liberty engine, piloted by Signal Electrician Elmer J. Spencer and carrying Major M. J. Boots as a passenger, established Nov. 7 what is believed to be a new non-stop record for this country in a flight from Selfridge Field, Mount Clemens, Mich., to Yonkers, N. Y., more than 700 miles, in 4 hours and 30 minutes. Leaving Mount Clemens at 11:40 a.m., they landed at Yonkers at 4:10 p.m.

An average speed of 144 miles an hour was made in the flight with a maximum altitude of 9000 feet. The route after leaving Mount Clemens was over Toronto, then following the Adirondack Mountains and the Hudson River to Yonkers.

New Type of Rotary Engine

It does not require demonstration to state that no other single factor has had such a far-reaching influence on the pre-war development of the airplane as the rotary engine, and particularly its first successful representative, the Gnôme. At the time of its appearance, and for several years thereafter, the rotary seemed to represent the aviation engine *par excellence;* so much so that the stationary types, derived from automobile practice, had little chance to undo the predominance of the rotary.

The striking success of the rotary engine was almost entirely due to its low specific weight; that is, weight per horsepower, which was mainly obtained, as is well known, by the absence of a crankshaft and a crank case. This feature of light weight was so important in the days when, for want of experience in the construction of light tubular and wooden structures, airplanes represented considerable dead weight, and correspondingly carried very small useful loads, that the advantages of the rotary decidedly outweighed its drawbacks some of which were quite of a serious nature. Principal among these drawbacks was high fuel and oil consumption, lack of flexibility, owing to automatic intake valves, and a certain structural weakness, leading to unreliability, which was due to insufficient cooling means, afforded the valve mechanism.



CROSS SECTION OF THE 40 HP. STATAX ENGINE

While some of these drawbacks were eventually overcome, greater reliability and flexibility, and lesser oil consumption, being obtained by the adoption of mechanical intake valves (Le Rhône), and the single valve mechanism (Gnôme monosoupape), other problems arose as the rotary developed in power. Owing to the compactness of the central crankcase, the number of cylinders that could be fitted to it was limited not only by the diameter of the crankcase, but also by the number of connecting rods that could be fitted, without mutual interference, to the driving crank. As a consequence, there was a limit to the increase in power by means of increasing the number of cylinders—this number having never exceeded nine in a single row, though there have been rotaries with 18 cylinders, disposed in two rows—and beyond that limit the power could be increased only by increasing the volume of the cylinders. This would obviously demand a larger crankcase, with the result that—beyond a certain power—the overall diameter of the rotary would increase in proportion to the power developed.

This increase in the dimensions of rotary engines possesses, however, a twofold drawback; first, it increases the cross-sectional area exposed to air resistance, thus requiring a larger airplane body and increasing parasite resistance; and second, the increase in size corresponding to an increase in weight, the centrifugal force generated by such a mass, rotating at a high rate of speed, has a distinctly unfavorable influence on a highly sensitive airplane, such as pursuit machine, which type particularly requires an engine of low specific weight.

The above considerations explain why the power of rotary engines is virtually limited to about 150 hp., and why, for engines of higher power, the stationary type has now come to be accepted almost as a dogma.

Nevetheless, it might be worth while examining whether the principle of rotary motion might not advantageously be retained for aero-engines, were it possible to do away with the above outlined drawbacks; that is, reduce wastage of fuel and oil, and overall dimensions, with its subsidiary defects.

An engine in which an attempt is made to conciliate these somewhat conflicting principles, and which has actually been built and tested, is described by Vincent Clarke in *Flying* (London). This engine, called the Statax, is of what may be called the parallel-rotary type, and embodies some very interesting features, not the least of which is the apparent simplicity of its general arrangement and the lack of complicated parts.

A three-cylinder engine was first manufactured, having cylinders 59 mm. diameter by 66 mm. stroke, and it developed 10 hp. when running at a speed of 1400 r.p.m. This was air-cooled and gave good results on test, but naturally is too small to be of much interest from an aviation point of view. A larger Statax engine was constructed with five cylinders, 100 mm. bore by 120 mm. stroke, and when running at 1200 r.p.m. an output of 44 hp. was obtained.

From the encouraging results of these engines a 100 hp. size was decided upon, having ten cylinders, 90 mm. diameter and 160 mm. stroke.

One of the chief advantages of this parallel-rotary type of engine is that, owing to the disposition of the cylinders, the engine is of very small diameter as compared with any other aero engine, which reduces parasite resistance to a minimum and allows the airscrew to be considerably more efficient. Referring to the diagram above, it is seen that the cylinders are arranged parallel to a fixed shaft, around which they rotate. Nickel steel cylinders are used, they being machined out of the solid, and the bore being finished by grinding. Mechanically operated inlet and exhaust valves are arranged in the cylinder head, and are provided with means for balancing the opening effort due to centrifugal force.

The advantages of this engine from the viewpoint of specific weight (lb. per hp.), fuel consumption, airscrew thrust, area of cross-sectional projection in flight and resultant parasite resistance are illustrated in the following tables in comparison with the results obtained for two aero-engines of about the some power, one of which is a radial rotary (Gnome), while the other is a stationary type (N. A. G.).

TABLE I

Engine	Hp.	R.p.m.	Exposed Cross-sectional area	Air resistance at 62 m.p.h.
Statax.....	44	1,200	1.1 sq. ft.	11.7 lb.
Gnome.....	45	1,250	5.4 sq. ft.	58.0 lb.
N.A.G.....	50	1,350	2.05 sq. ft.	22.0 lb.

TABLE II

Engine	Weight (lb.)	Consumption		Working weight for 7 hours (lb.)	Normal Airscrew Thrust (lb.)	Flight Thrust at 62 m.p.h. (lb.)
		Gasoline (oz.)	Oil (oz.)			
Statax.....	176	8.5	¾	355	272	260
Gnome.....	172	12.5	3	415	272	214
N.A.G.*...	275	8.2	½	463	283	260

* Exclusive of radiator, pipes and water.

Digest of the Foreign Aeronautical Press

Aeronautics, Oct. 2, 1918

Aluminum and Its Alloys—Their Future After the War. Paper read by Dr. Rosenhain, F.R.S., at the British Scientific Products Exhibition, Sept. 4, 1918—Since 1914 very great and vitally important strides have been made in the development of aluminum alloys for many purposes on the largest scale. Most of these refer to the requirements of aircraft and, consequently, it is not possible to deal with them at the present time.

GERMAN OBSERVER JUMPING FROM HIS BALLOON AFTER IT HAD BEEN FIRED BY ALLIED AVIATORS
Central News Photo Service

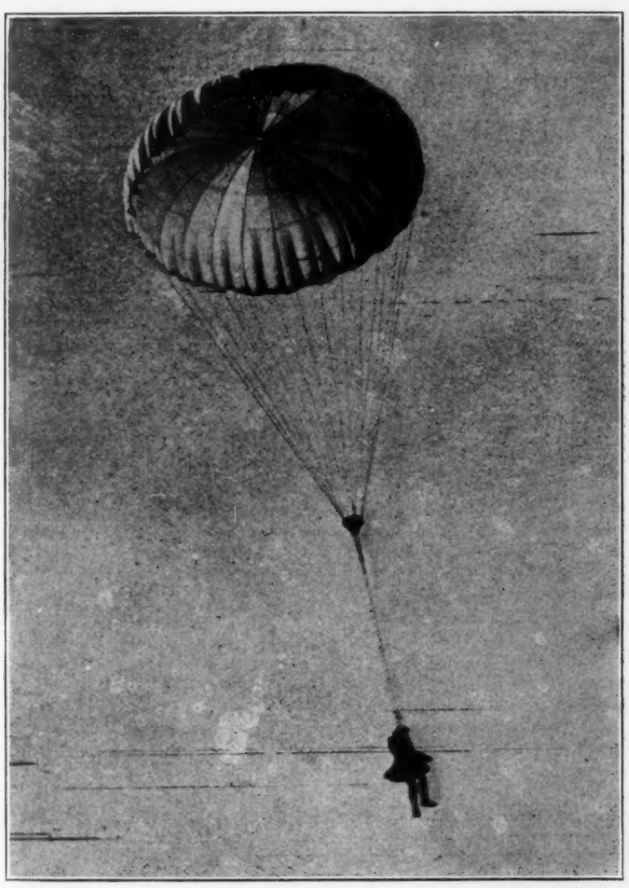
The uses and possibilities of aluminum alloys in aircraft are, however, of a fairly obvious character, and the field for their further extension in future commercial aeronautics are recognized and understood.

The valuable properties of aluminum and its alloys depend primarily on the lightness of aluminum. The pure metal has a specific gravity of about 2.6 as compared with 7.9 in the case of steel, or—putting it in another way—while a cubic foot of steel weighs about 490 lb., a cubic foot of aluminum only weighs about 160 lb. But lightness by itself is of little value—for that reason pure aluminum, with a tensile strength of from 5 to 7 tons per square inch, finds little use for engineering purposes. What is required is a combination of great strength with lightness. This has been attained to an astonishing degree in the modern aluminum alloys. As an example, the material used in the construction of a German Zeppelin airship framework may be cited. This has a density of about 2.9 and a tensile strength of about 25 tons per square inch. This example has been chosen because the figures can be given without publishing undesirable information, and also because it is well within the mark to state that alloys considerably better than this have been developed by us. But even this example is sufficiently striking.

The effect of this combination of strength and lightness may be illustrated by imagining a very long vertical bar of metal to be hung up by its upper end. The longer such a bar is made, the greater the pull or tensile stress on its upper end must become, until ultimately a length of bar is reached which can only just support its own weight. The length of such an imaginary bar—which can be easily calculated if the density and strength of the metal are known—gives a very good measure of the value or "figure of merit" of the material in question; it depends upon the ratio of the density or weight of the metal to its tensile strength. Now in the case of good ordinary structural steel, such as is used for roofs and bridges, the limiting length of bar which could just bear its own weight when suspended vertically would be about 20,000 feet—rather less than four miles. For the alloy described above, on the other hand, the length would be about 50,000 ft., or between nine and ten miles. And for the still better alloys which are now available, the length would be considerably greater still.

The Aeroplane, Oct. 23, 1918

Air Transport Companies Formed.—The Anglo-American Aerial Services, Limited, have been formed to establish, maintain, and operate lines of aerial conveyance between the United Kingdom and the United States, Canada, and Central and



PARACHUTE DESCENT FROM A BRITISH OBSERVATION BALLOON
British Official *Feature Photo Service*

South America, and between the continents of North and South America, and to carry on the business of manufacturers of and dealers in aircraft, hangar and aerodrome proprietors, tourist agents, contractors, etc.

The London and Provincial Aerial Services, Limited, has been formed with the object denoted by the name.

According to advices from Helsingfors, an air traffic company has been formed there with a share capital of two million Finnish marks (francs).

Cable messages from Sydney state that a local company has been formed with the object of arranging the preliminaries for an aerial mail service between Australia and England. At a meeting in Sydney, on October 2, of representative business men, it was stated that the flight would take 150 hours, and sufficient capital was guaranteed for the purpose, provided that permission was obtainable.

News of the Fortnight

New Flying Boat Tested

A demonstration of the largest seaplane in the United States was given to the press in Washington, D. C., on Nov. 8. The flight, which was also attended by several naval officers, was witnessed from a navy launch on the Potomac River. Before the seaplane started on its trip, which was to Hampton Roads, Va., it was inspected by Rear Admiral David W. Taylor, Chief of the Bureau of Construction and Repair; Rear Admiral R. S. Griffin, of the Bureau of Steam Engineering, and Captain G. W. Steele, of the Aviation Division.

This plane, which is known as the NC-1, had flown from a coast patrol station in New York on the same day and landed at the naval air station at Anacostia. It carried fifteen officers. It was constructed from the design of the Aircraft Division, Bureau of Construction and Repair, the chief of which is Naval Constructor J. C. Hunsaker. The following details of the plane, which are approximately correct, have been furnished:

Its wings stretch over a linear distance of 126 feet. Three twelve-cylinder Liberty engines propel the machine. The pilot has his seat and engine controls between the lower and upper wings.

Below the lower wing seats for four officers are fixed, and below that the boat part of the plane has a capacity for a number of observers. Above the top wing, in the center of the plane, is an observer's post. He has a commanding view of everything, as he sits considerably above the wings of the plane.

The plane has a capacity of 300 gallons of gasoline and is used on coast patrol duty, requiring much flying with little opportunity for getting fuel.

The NC-1 is being manufactured at the Naval Aircraft Factory, Philadelphia, and at the factory of the Curtiss Engineering Corp., Garden City, N. Y.

Aircraft to Chart U. S.

Every important community from coast to coast will be connected by a series of "air links" when Army aviators from various flying fields have completed a task that they undertake.

They will make a series of cross-country flights in their respective sections to collect general aviation statistics, chart air lanes, make air maps and select prospective sites for landing fields and airdromes.

Col. M. F. Davis, head of the training section, has been placed in charge of this work by Major-Gen. Kenly, Director of Military Aeronautics.

The dromes that will be constructed on the sites selected will be used not only to provide shelter for aviators but also to house the flying equipment that will be brought back from overseas with the return of the troops. Combat pilots trained for overseas duty but whose battle training has by the signing of the armistice been diverted to preparing for peace, will make the survey flights.

Their work will include bringing up to date extensive maps made years ago by the United States Cavalry and showing available shelters, locations of batteries, good and bad roads, fords, sources of food and water and bridges.

Liberty Engine Production

American factories making Liberty engines produced in October 1500 more engines than in September. The total number of engines expected from all contractors in September was 2500, while the number actually shipped was 2378. For October the quota for all manufacturers was 3000, and 3878 engines were actually delivered. The total quota set for November is 4350.

Biggest Airplane in the World

A new Handley Page airplane set up a record in its flight on Nov. 15 when it took up no fewer than forty passengers for a trip over London. The previous record was twenty.

This giant machine is the first of a series that had been specially constructed to bomb Berlin, but it was not completed until three days after the signing of the armistice. It is easily the biggest airplane in the world.

A. S. Adams Killed in Fog

While trying in an almost impenetrable fog to locate a landing place, Allan S. Adams, testing pilot for the L-W-F Engineering Co., of College Point, N. Y., crashed in an L-W-F Model G biplane and was instantly killed at Central Park, L. I., Nov. 18. His mechanic, Chas. Ahrens, in the rear seat, escaped with a fractured arm.

Adams in the L-W-F, Model G, was scheduled to leave Belmont Park with 400 pounds of United States mail on the regular New York-Washington run, for the first mail trip for both pilot and machine.

Adams ascended through the fog at the L-W-F flying field at Central Park to test the Liberty 12 engine and if possible to fly over to Belmont Park, about 10 miles east, to be on hand for his scheduled flight with the mail. He evidently soon found the fog as thick aloft as it was on the ground. In trying to locate the L-W-F field, with the ground indistinguishable at 200 feet, Adams to avoid crashing into a barn climbed suddenly at such a sharp angle that the machine stalled and went into a dive from which it was impossible to recover so close to the ground.

Allan S. Adams had been flying since 1910, when he built his own machine and taught himself to fly it at Dominguez Field, near Los Angeles. In 1912 he came East to the Mineola School, where he remained as an instructor and test pilot until the spring of 1914.

During the spring of 1914 he went on the road on exhibition work flying a Blériot monoplane.

In 1915 Adams went to Canada with the Miller, Fairchild & Phipps Co. and flew their all-steel machine. He remained with this company until the summer of 1916, when he joined the First N. Y. N. G. Aero Squadron under Lieut.-Col. Raynal C. Bolling, which was encamped at Mineola during the Mexican mobilization. He also served as an instructor with Lieut.-Col. J. A. Carberry when Carberry commanded the first regular aero squadron during the latter part of 1916 at Mineola. From December, 1917, until the end of February, 1918, Adams was employed by the Army in airplane testing at Hampton, Va. In March, 1918, he was employed by the L-W-F Engineering Corporation of College Point, Long Island, as test pilot. He tested the L-W-F Model F, two-place advanced training machine, with a Sturtevant 210-hp. engine at Mineola. During the summer and fall of this year he made frequent flights under all conditions with the L-W-F Model G two-seater fighter.

R. C. Byler Promoted

Robert C. Byler, for nearly four years advertising production man for the S K F Ball Bearing Company of Hartford, Conn., has been appointed Advertising Manager of the S K F Administrative Company of New York City and will direct the advertising of the S K F Ball Bearing Company of Hartford, the Hess-Bright Mfg. Co. of Philadelphia and the Atlas Ball Company of the same city, all of which are controlled by the S K F Administrative Company.

Until arrangements are made in New York City, Mr. Byler will remain with the S K F Ball Bearing Company of Hartford, Conn.

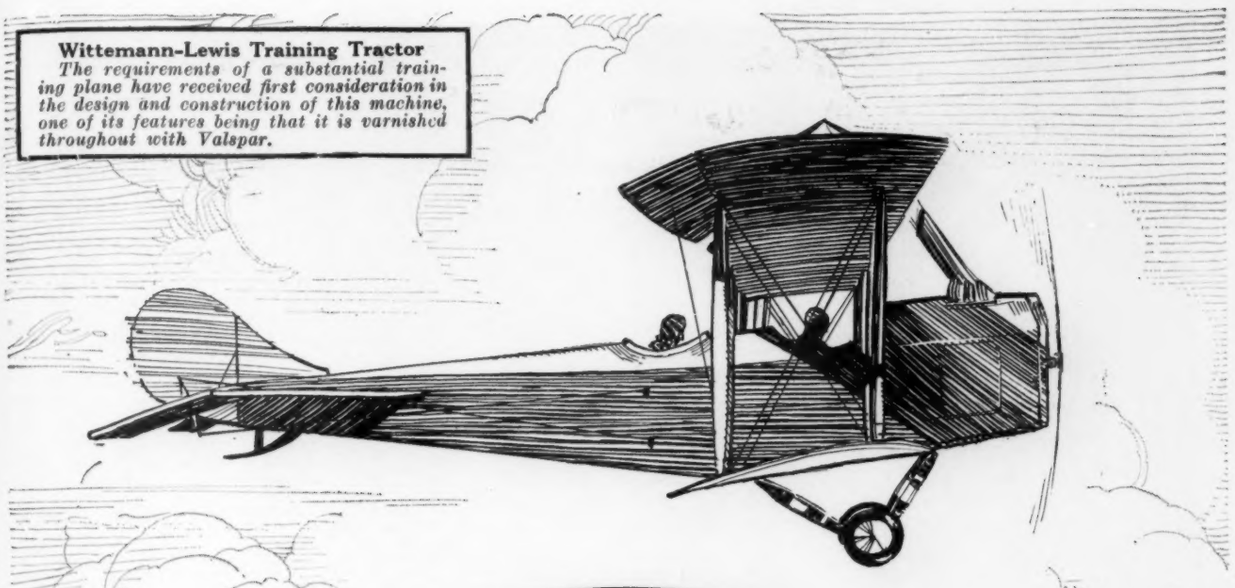
Horace N. Trumbull, formerly Advertising Manager of the S K F Ball Bearing Company, of Hartford, Conn., has entered the Reserve Officers' Training Camp at New Haven, Conn.

Airplane Wood in Alaska

By executive order, the tract of land in Alaska lying south of the parallel of 58 degrees 50 minutes north latitude and west of the meridian of 137 degrees 40 minutes west longitude and bounded on the west by the Gulf of Alaska, has been temporarily withdrawn from settlement, location, sale, or entry for the purpose of providing timber for use in the construction of airplanes.

Anderson Heads Aircraft Publicity

Lee Anderson, vice-president and sales manager of the Hupp Motor Car Corp., of Detroit, has been put in charge of publicity for the Aircraft Production Bureau in Detroit. Means to stimulate production are planned and worked out in this office.



Wittemann-Lewis Training Tractor
The requirements of a substantial training plane have received first consideration in the design and construction of this machine, one of its features being that it is varnished throughout with Valspar.

Wittemann-Lewis say

Valspar gives best results

"WITH reference to your Valspar Varnish, as well as other paints which we have used for several years, would say they have given us the very best of results, and take pleasure in advising you that *wing surfaces that have been varnished with your Valspar varnish as long as a year and nine months ago are still in a perfectly pliable and healthy condition.*"

WITTEMANN-LEWIS AIRCRAFT CO.

Newark, N. J., Sept. 12, 1918. (Signed) Paul W. Wittemann,
Treasurer.

VALSPAR is waterproof and weatherproof. It will not turn white or blister with exposure. It protects wood, metal or fabric with equal reliability. It is durable beyond all ordinary varnishes.

Valspar is universally accepted as the standard airplane and seaplane varnish.

Our Airplane Department willingly places its experience at the disposal of all airplane and seaplane manufacturers.

To purchasing agents and superintendents of production a valuable book full of information on airplane finishing will be sent free on request.

VALENTINE & COMPANY, 456 Fourth Avenue, N. Y.

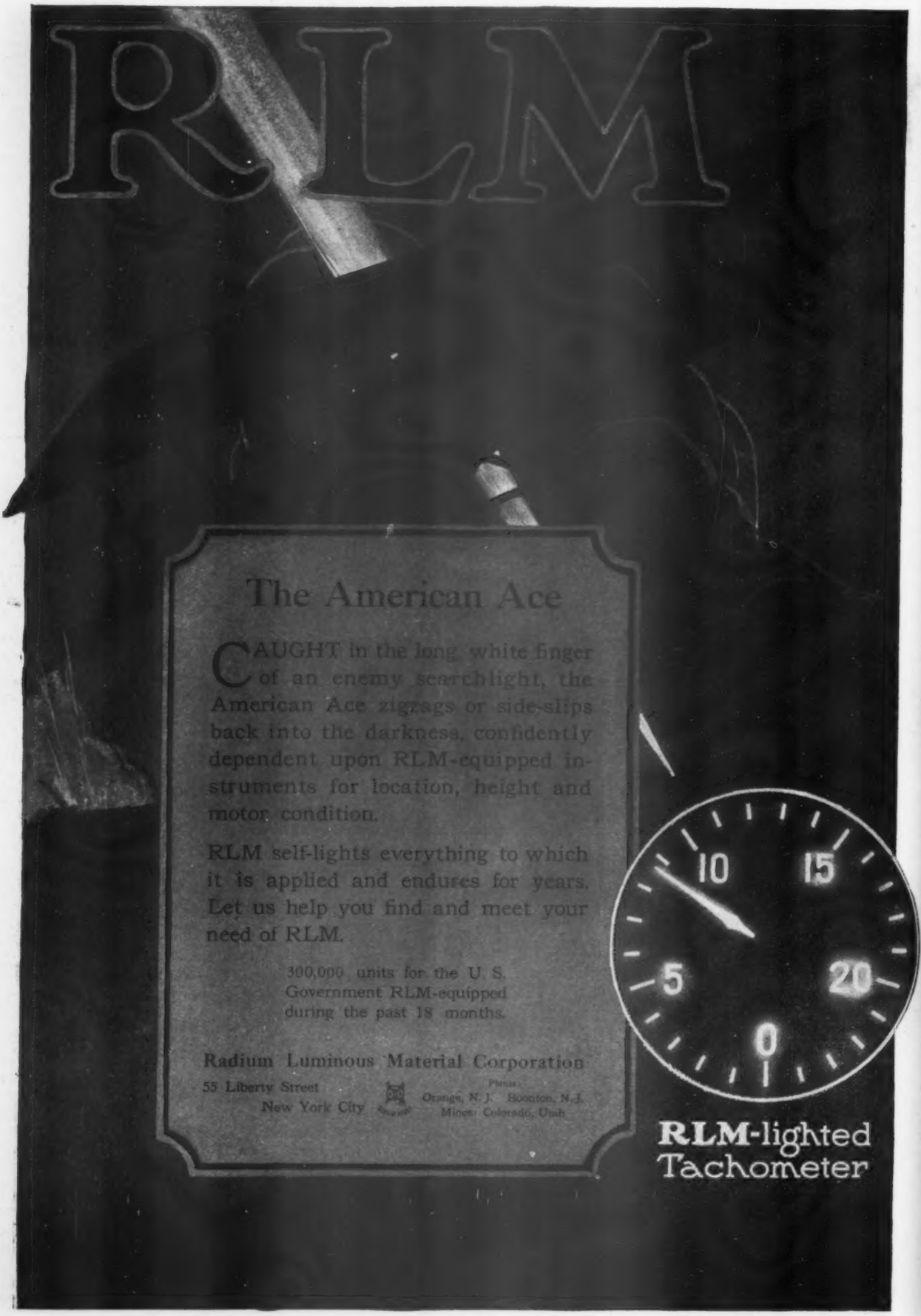
Largest Manufacturers of High-grade Varnishes in the World—ESTABLISHED 1832

New York Chicago Boston Trade VALENTINES VARNISH Mark Toronto London Amsterdam

W. P. FULLER & CO., Agents for the Pacific Coast; San Francisco and Principal Pacific Coast Cities

VALENTINE'S
VALSPAR
'The Varnish That Won't Turn White

Valentine Products used by the world's leading airplane-makers include: Valspar Varnish, Valspar Bristol Enamel, Valspar Low Visibility Gray Enamel, Valspar Olive-Drab Enamel, Valspar Black Enamel, Valspar Filler (Wood), Valspar Primer (Metal), Valspar Primer (Wood), Valspar Khaki Enamel, Valspar Aluminum Paint. Dipping, Spraying, and Brushing coatings of all kinds, Quick-Drying Insignia Colors.


RLM
The American Ace
CAUGHT in the long white finger of an enemy searchlight, the American Ace zigzags or side-slips back into the darkness, confidently dependent upon RLM-equipped instruments for location, height and motor condition.
RLM self-lights everything to which it is applied and endures for years. Let us help you find and meet your need of RLM.
300,000 units for the U. S. Government RLM-equipped during the past 18 months.
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Mines: Colorado, Utah
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15
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20
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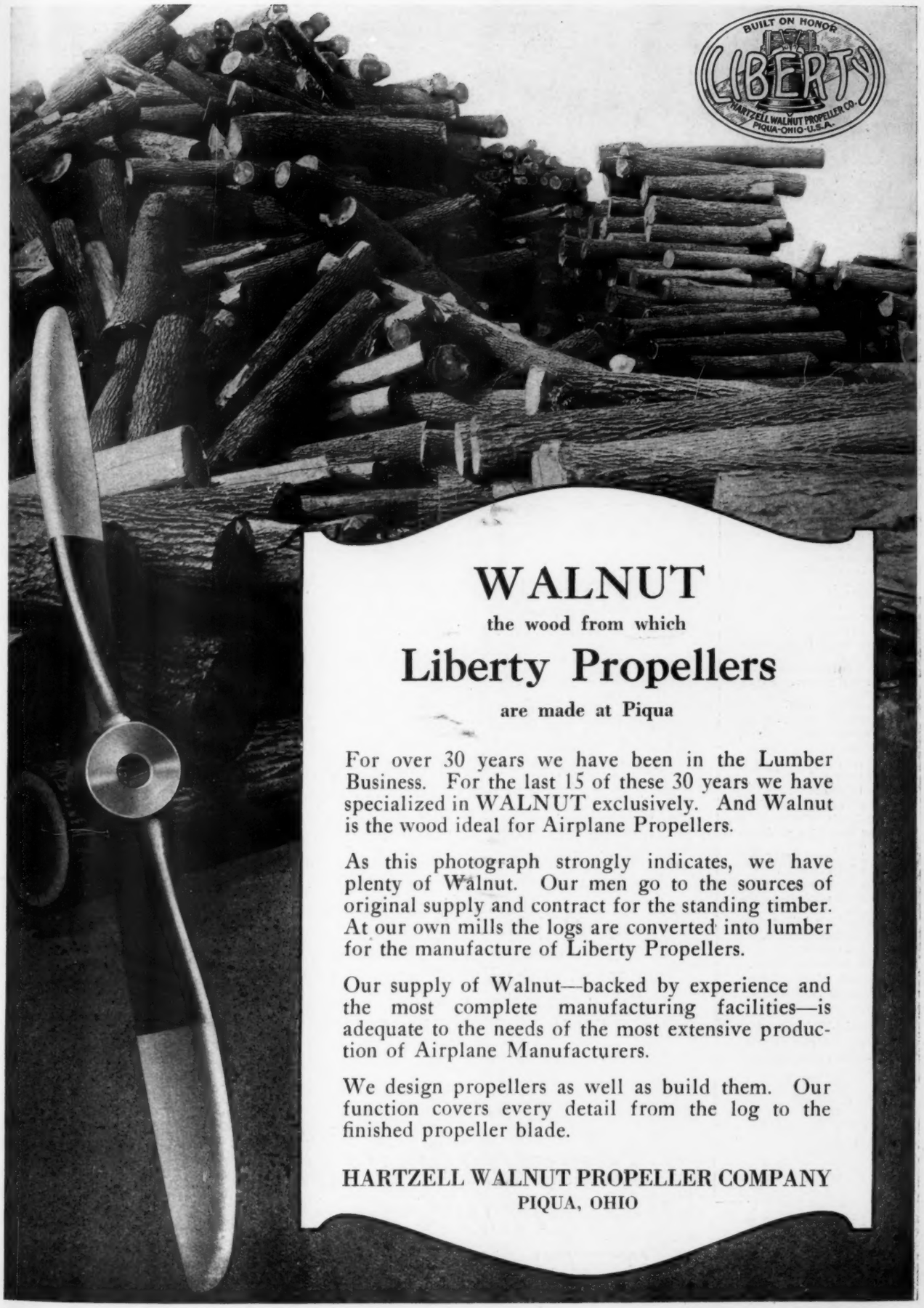
RLM-lighted Tachometer



WALNUT

the wood from which

Liberty Propellers

are made at Piqua

For over 30 years we have been in the Lumber Business. For the last 15 of these 30 years we have specialized in WALNUT exclusively. And Walnut is the wood ideal for Airplane Propellers.

As this photograph strongly indicates, we have plenty of Walnut. Our men go to the sources of original supply and contract for the standing timber. At our own mills the logs are converted into lumber for the manufacture of Liberty Propellers.

Our supply of Walnut—backed by experience and the most complete manufacturing facilities—is adequate to the needs of the most extensive production of Airplane Manufacturers.

We design propellers as well as build them. Our function covers every detail from the log to the finished propeller blade.

HARTZELL WALNUT PROPELLER COMPANY
PIQUA, OHIO

Protecting *the* Air Fleet 34 Ways

Success in fight or flight may depend directly on the varnish used. When wings are punctured the " dope " and Varnish must hold fabric against stretch or spread.

Airplanes to win must endure all extremes of temperature and climate.

When a varnish is put on an airplane it must be able to endure the noonday's sun in the Mesopotamian Desert and Arctic nights on the Murman coast equally well and without the slightest impairment.

The U. S. Varnish requirements for airplanes are so exacting that only the best varnish can expect to meet them. Thirty-four tests must be met. These requirements include every test to which a varnish may be put in war, home or industry.

Air-Plane Rexpar Varnish has met these thirty-four tests and received a first order for 50,000 gallons.

Every gallon of Air-Plane Rexpar Varnish is equal in quality to every other gallon.

Air-Plane Rexpar will merit your approval just as it merited the approval of the United States Government.

We can make immediate delivery of Air-Plane Rexpar Varnish in any possible quantity that you may require.

The Sherwin-Williams Company

801 Canal Road, Cleveland, Ohio

Branch Offices and Warehouses in all Important Cities

The varnish on airplanes shall

1. Protect wood.
2. Protect doped linen.
3. Protect doped cotton.
4. Protect metal.
5. Be long oil varnish.
6. Resist air.
7. Resist light.
8. Resist water.
9. Resist natural gas.
10. Resist illuminating gas.
11. Have proper brushing qualities.
12. Have proper flowing qualities.
13. Have proper covering qualities.
14. Have suitable body.
15. Dry dust free rapidly.
16. Harden rapidly.
17. Be elastic.
18. Be clear.
19. Be transparent.
20. Be highest quality.
21. Match a fixed color solution.
22. Be durable.
23. Not flash below 95 degrees Fahr.
24. Not whiten under water.
25. Not dull under water.
26. Not show defects under water.
27. Stand air test during application.
28. Stand air test during drying.
29. Meet a fixed setting test.
30. Meet a threefold drying test.
31. Meet a severe bending test.
32. Be inspected before shipment.
33. Be inspected at destination.
34. Prove durable under fixed test.

Sherwin-Williams Air-Plane Rexpar meets all these requirements

SHERWIN-WILLIAMS PRODUCTS

PAINTS AND VARNISHES

DYESTUFFS, COLORS, PIGMENTS, CHEMICALS, INSECTICIDES, DISINFECTANTS, WOOD PRESERVATIVES

BOYCE MOTO METER
In active service
The Boyce Moto-Meter is proving itself as dependable under fire as the men who pilot the 'planes and work the guns.
The Boyce Moto-Meter has honestly earned its right to do its bit. It has shown itself capable, in any emergency, of telling the pilot the exact temperature of his motor.
Moreover, it is the only motor heat indicator which registers every degree of temperature from boiling to freezing, and which operates with absolute accuracy regardless of the altitude.
THE MOTO-METER COMPANY, Inc.
Contractors to the U. S. Government
Creators of motor heat indicators. Exclusive licensees of the "Boyce" fundamental patents.
150
180
120
212
90
60
32
BOYCE MOTO METER
TYPE-E
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BOYCE
MOTO METER

AIRCRAFT + PEACE= ?

Organizations representing millions of capital, an army of workers, thousands of aviators and mechanics are waiting for an answer.

Every fact which will throw authentic light on this far-reaching problem may be of inestimable value.

In a forthcoming issue AVIATION AND AERONAUTICAL ENGINEERING will present:

All available facts relating to the policy of the United States for its permanent aeronautical establishment.

Articles on commercial aeronautics from the standpoint of the designer, engineer, manufacturer, the aviator and enthusiast.

Views of the leading men of the industry, of the production and operating departments of the Air Service.

Bunk and propaganda will be avoided—instead the

Commercial Aeronautics Issue of Aviation and Aeronautical Engineering

will be crammed full of facts and figures bearing upon every phase of the period of transition between war and peace and the outlook for commercial aeronautics.

This special issue will be a distinct contribution to the literature of aeronautics, a guide and a text book.

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AVIATION AND AERONAUTICAL ENGINEERING
120 W. 32d Street, New York City

Thomas

THOMAS-MORSE AIRCRAFT CORPORATION

ITHACA, N.Y. U.S.A.

Contractors to U. S. Government

ACKERMAN
LANDING
GEAR
Is the latest and highest development in the construction of Landing Gear
Their
SIMPLICITY
STRENGTH
and SERVICE
make them the logical equipment for the Modern Airplane.
Weight 96 pounds complete with tires built for craft weighing 2500 pounds
WHEELS and LANDING GEARS built for any size machine
Complete data on Ackerman Equipment available for Designers and Engineers.
THE ACKERMAN WHEEL COMPANY
542 Rockefeller Building, CLEVELAND, OHIO. U.S.A.

WE USE THE CELEBRATED

LUMA RADIUM

Radium Luminous Compound

Luma-lited Dials are Always Visible

Manufacturers of aeronautic instruments can save much expense, inconvenience and uncertainty by sending us their dials to be illumined.

We use Luma exclusively. Its superior luminosity, long life and dependability have long been recognized. Guaranteed to contain only Radium as its activating agent. Approved by Great Britain and the United States Government for use in military air service.

Our work is of the highest character and assures results of unvarying excellence.

Estimates and full information upon request.

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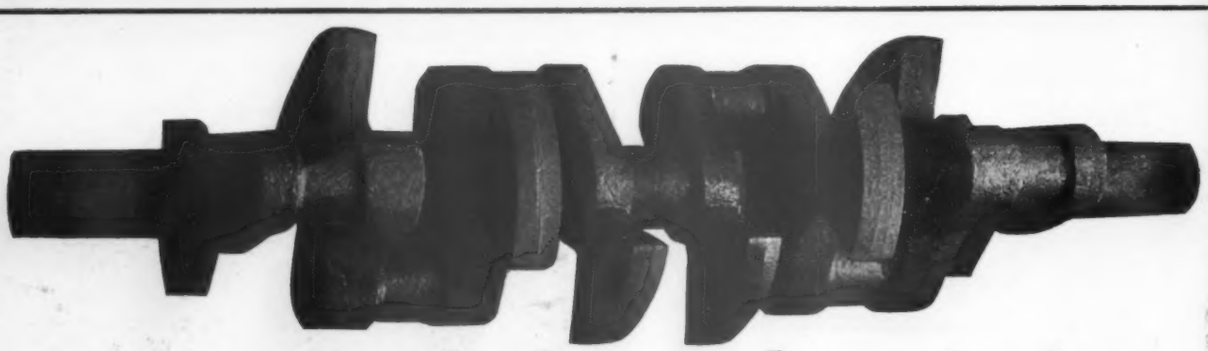
DIAL PAINTING FACTORIES - PITTSBURGH - LONG ISLAND CITY - CHICAGO - BOSTON



a counterbalanced aviation crankshaft . . . .

Patented July 10th, 1917

one of the 18 different
models we are now making
for 14 aviation motor companies . . .
reduces vibration and eliminates bearing pressure

We have shipped 41,281 Aviation Crankshafts to November 18, 1918

THE PARK DROP FORGE CO. CLEVELAND, OHIO

The *Real* Article

The *American* Aviator
The *American* Airplane
The *American* Goggle

THE AVIGLAS

NOVIOL glass as used in the Aviglas takes the glare out of the sunlight.

THE MOST IMPORTANT THING FOR THE AVIATOR IS TO BE ABLE TO SEE CLEARLY AND DISTINCTLY.

Write to us for illustrations and prices on the various types.

Designed and Patented by

F. A. Hardy & Company
John H. Hardin, *President*
Department N, P. O. Box 804, Chicago, Ill.

Denmark's experts agree with American airmen

THOMSEN, HEIN & CHRISTENSEN
Sept. 3rd. 1918.
Ericsson Mfg. Co.
Buffalo N. Y. U.S.A.
Gentlemen.-
My long experience in the marine-motor line has taught me that your magneto is widely superior to all other ignition systems and no other make has given better service than the BERLING, which I have had ample opportunity to test on the Sterling marine motors.
I enclose a photo of Denmark's fastest runabout—a 30 mile Hand V-bottom speedster—Berling and Sterling equipped.
Very truly yours.
Ericsson Manufacturing Company
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Berling
WORTH MORE
Magneto
DOES MORE

ERIE STANDARD
AIRCRAFT METAL PARTS

DEPENDABLE SERVICE
QUANTITY-PRODUCTION

Our plant at Erie—the largest of its kind—specializes on AIRCRAFT BOLTS, NUTS and CLEVIS PINS conforming to Government Specifications.

A product as near 100% perfect in quality and machine practice as the human element will permit.

Please request our New York Office to send you copy of our catalogue.

ERIE SPECIALTY COMPANY.
8 West 40th St., New York City
Main Plant Erie, Pa.

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MACHINE - WOOD - CAP - SET - LAG - ETC.

WE HAVE THE ASSORTMENT
AND THE QUANTITY

Let us figure on your next specifications. We have managed to "take care" of some very large concerns both in price and delivery

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

New York, Since 1848 4th Ave. and 13th St.

Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of companies listed below.
Names of Advertisers in this issue are printed in capitals.
See Index to Advertisers on page 525

ACCESSORIES AND INSTRUMENTS

Advance Felt Specialty & Cutting Co.
International Aeronautical Instrument Corp.
JOHNS-MANVILLE, H. W., CO.
King, Julius, Optical Co.
THE MOTO-METER CO.
National Gauge & Equipment Co.
Nelson Blower & Furnace Co.
O'Hara Waltham Dial Co.
Queen-Gray Co.
Rieker, Walter.
SPERRY GYROSCOPE CO.
Standard Aeronautical Co.
Stewart-Warner Speedometer Corp.
TAYLOR INSTRUMENT COMPANIES
VEEDER MFG. CO.
Western Electric Co.

AIRPLANES

Aeromarine Plane and Motor Co.
Blackhawk Airplane Co.
Blanchard-Radley Aircraft Co.
BOEING AIRPLANE CO.
Breese Aircraft Corp.
THE BURGESS COMPANY.
Continental Aircraft Corp.
CURTISS AEROPLANE & MOTOR CORP.
DAYTON-WRIGHT AIRPLANE CO.
Des Lauriers Aircraft Corp.
Dewey Aeroplane Co.
Engel Aircraft Co.
Fisher Body Corp.
Fowler Airplane Corp.
Gallaudet Aircraft Corp.
Lanzius Aircraft Co.
Lawrence-Lewis Aeroplane Co.
Lawson Aircraft Corp.
Lewis & Vought Corp.
Liberty Iron Works
Loening Aeronautical Eng. Corp.
Longren Aeroplane Co.
L. W. F. ENGINEERING CO.
Martin Aeroplane Factory
MARTIN, GLENN L., CO.
Michigan Aircraft Corp.
Ordnance Eng'ring Corp.
Patterson Aeroplane Co.
Peirce, Sam'l S., Aeroplane Corp.
RUBAY CO.
St. Louis Aircraft Co.
Smith, Kyle, Aircraft Co.
Sperry, Lawrence, Aircraft Co.
Springfield Airplane Co.
STANDARD AIRCRAFT CORP.
Sturtevant Aeroplane Co.
THOMAS-MORSE AIRCRAFT CORP.
The Willys-Morrow Co.
WITTEMANN-LEWIS AIRCRAFT CO.
Whittemore-Hamm Co.
WRIGHT-MARTIN AIRCRAFT CORP.

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CURTISS AEROPLANE & MOTOR CORP.
Detroit Gas Turbine Corp.
DUESENBERG MOTOR CORP.
General Ordnance Co.
General Vehicle Co.
Gyro Motor Co.
HALL-SCOTT MOTOR CAR CO.
Kemp Machine Works.
Kessler Motor Co.
Nordyke & Marmon.
Packard Motor Co.
Roberts Motor Mfg. Co.
Rolls-Royce, Ltd.
Sterling Engine Co.
Sturtevant, B. F., Co.
Trego Motors Corp.
THOMAS - MORSE AIRCRAFT CORP.
UNION GAS ENGINE CO.
Van Blerck Motor Co.
Willys-Overland Co.
WISCONSIN MOTOR MFG. CO.
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Astoria Veneer Mill & Dock Co.
BARCALO MFG. CO.
BUFFALO PRESSED STEEL CO.
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GENERAL BAKELITE CO.
Holbrook Co.
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KING SEWING MACHINE CO.
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New Jersey Veneer Co.
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Rogers Construction Co.
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WIDMAN, J. C., & CO.
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So-Luminum Mfg. & Eng. Co. (Solder)
STIMPSON, EDWIN B., CO.
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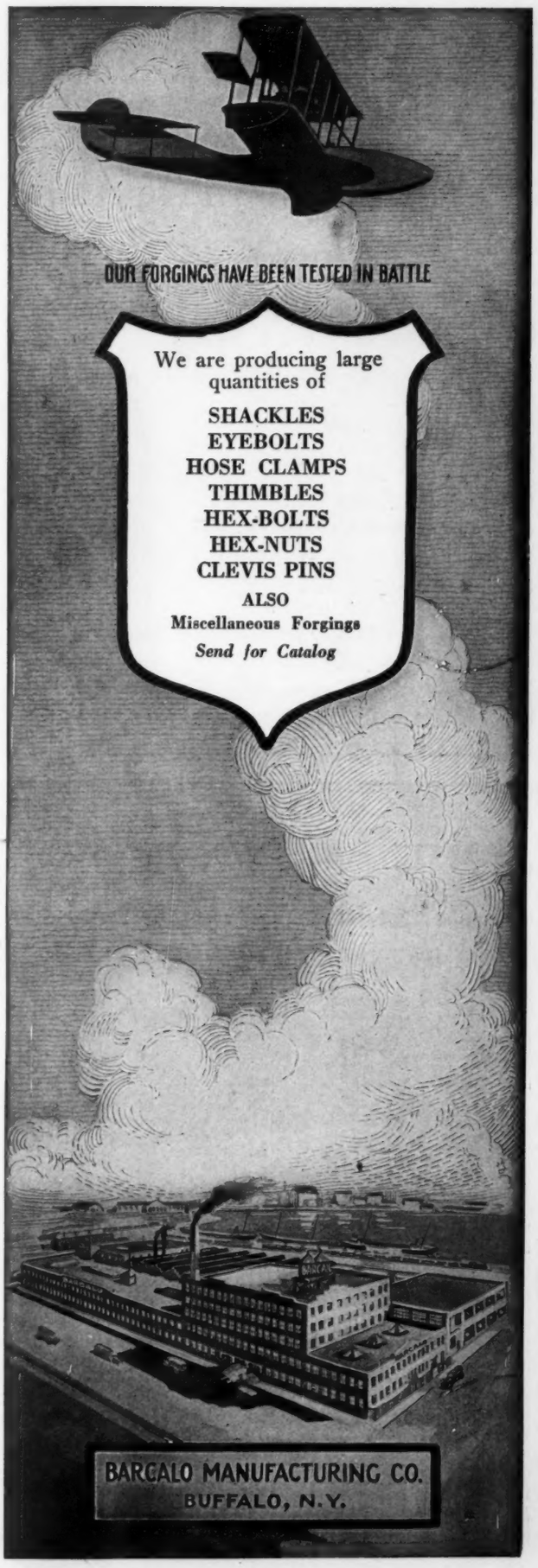
Michigan State Auto School
Morris, Bud Airplane School
Penn. State School of Aero-Mechanics
West Side Y. M. C. A.
Whittemore-Hamm Co.

(*Continued on page 581*)



Yates

Type C-20 Propeller Boring Machine

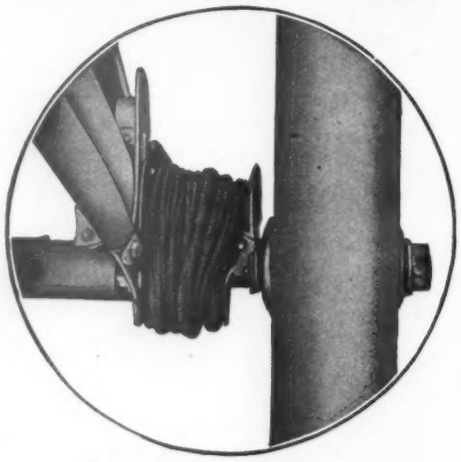
A recently perfected machine for automatically boring the necessary holes in the modern aeroplane propeller hub in one operation. Extremely durable, compact, and efficient. Does absolutely accurate and uniform work. Specially designed so that no oil can get on and injure the stock. Either belt or direct motor drive.

Send today for complete details

P. B. Yates Machine Co.
BELOIT, WISCONSIN, U. S. A.

Elastic Aviation Cord

For Shock Absorbers on Airplanes



We originated and have developed this special heavy elastic cord for airplane shock absorbers.
We are the largest manufacturers in the world of Heavy Elastic Cord and owing to our factory capacity we can make prompt deliveries.
Samples on request

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FACTORY: STOUGHTON, . .88.
OFFICES
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Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N. Y.

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of the

Highest Quality

to Meet the Most
Exact Requirements

Standard Turnbuckle Company

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New York Office: Woolworth Building

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NORMA COMPANY OF AMERICA
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Connecticut Aircraft Co.
Custer Specialty Co. (Statoscope)
Gas Engineering Co. (Gas Plants)
GOODYEAR TIRE AND RUBBER CO.
United States Rubber Co.

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Green, Henry J.
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Sussfield & Lorch
TAYLOR INSTRUMENT COMPANIES

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ALUMINUM CASTINGS CO.
AMERICAN BRONZE CORP.
FAHRIG METAL CO.
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Levett, Walker M., Co.
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Depollier, J., & Son
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Rainwear Co.
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Sanders Company
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Howe Varnish Co.
Lucas, John, Company
Masury, John W., & Son
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PRATT & LAMBERT
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Meisel Press Mfg. Co.
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Lamb, Finlay & Co.
McBratney, Robt., & Co.
Whitman, Clarence & Co.

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Booth Felt Co.
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GLUE
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Baeder & Adamson
Certus Cold Glue Co.
Ferdinand, L. W., & Co.
Widman, J. C., Co.

(*Continued on page* 583)

KAISER (loq.)· "How is it at such a height on so cold a morning the lubricants do not freeze?"

GEN. HÖPPNER: "The British have discovered the secret which we have been seeking for months." *Vide "Daily Mail," see above.*

C.D.C.

A British Firm beats the Germans

THE MANCHESTER PAGE.
After the two royalties had descended from the machine it was loaded with dummy bombs in preparation for a flight. The now famous German flying officer Richthofen took the seat which the Kaiser had vacated, and two other officers also boarded the plane. With a terrific roar the two engines were started, and like a bird the aeroplane rose in the air. It climbed rapidly to about 10,000ft., and the Kaiser turned to General Höppner, saying:
"How is it that, at such a height and on so cold a morning, the lubricants do not freeze?"
"The British have discovered the secret which we have been seeking for months," replied the general. "Our great difficulty is now surmounted. It

Extract from "Life in Essen." Eye-Witness's Account, "Daily Mail," April, 1918.

THE SECRET

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Castrol 'R' MOTOR OIL
(Racing)
was the lubricant used.
Castrol "R" possesses the lowest cold test of any known Aero Engine Oil.

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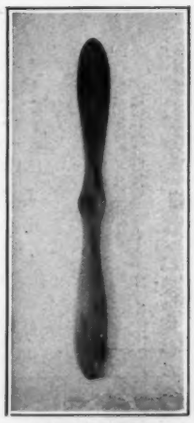
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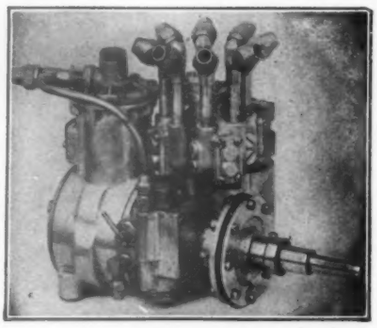

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(*Continued on page* 585)

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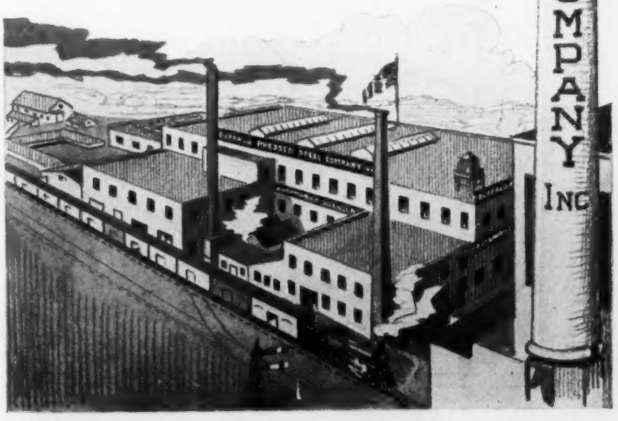

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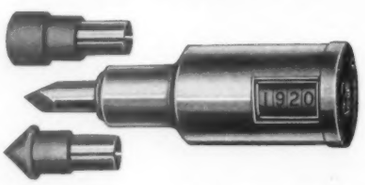

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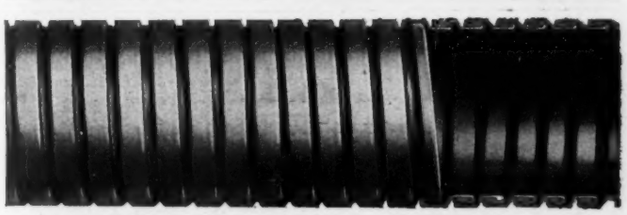

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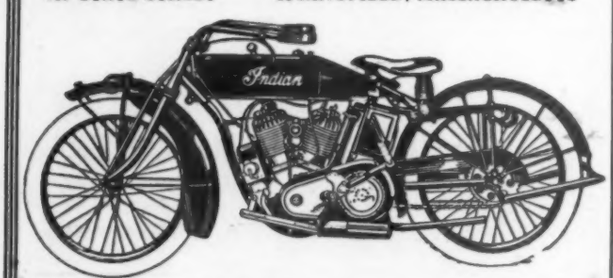

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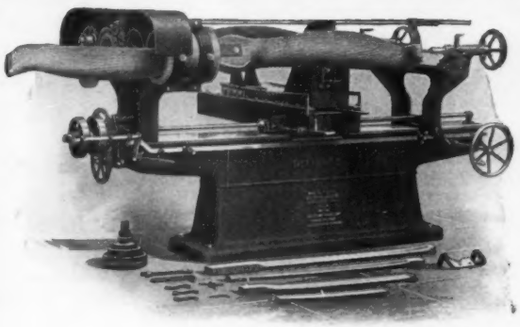

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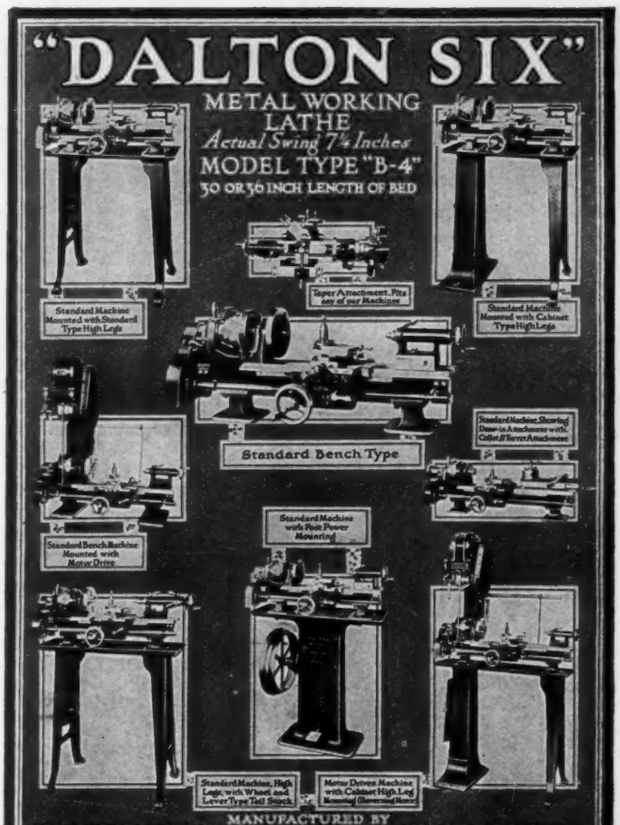
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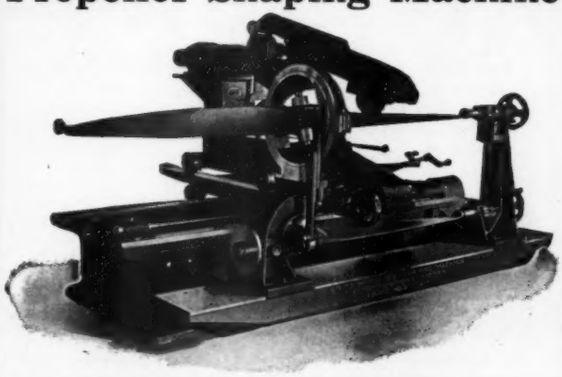

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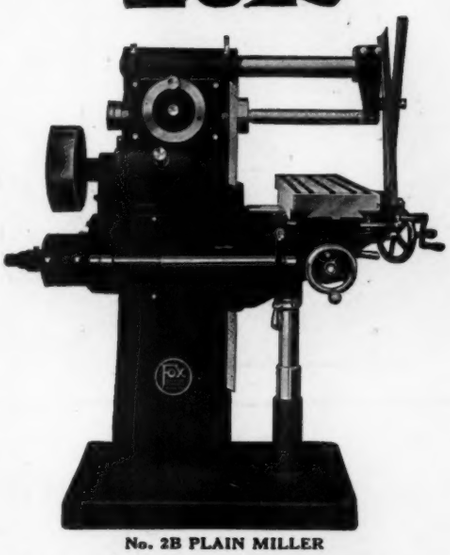

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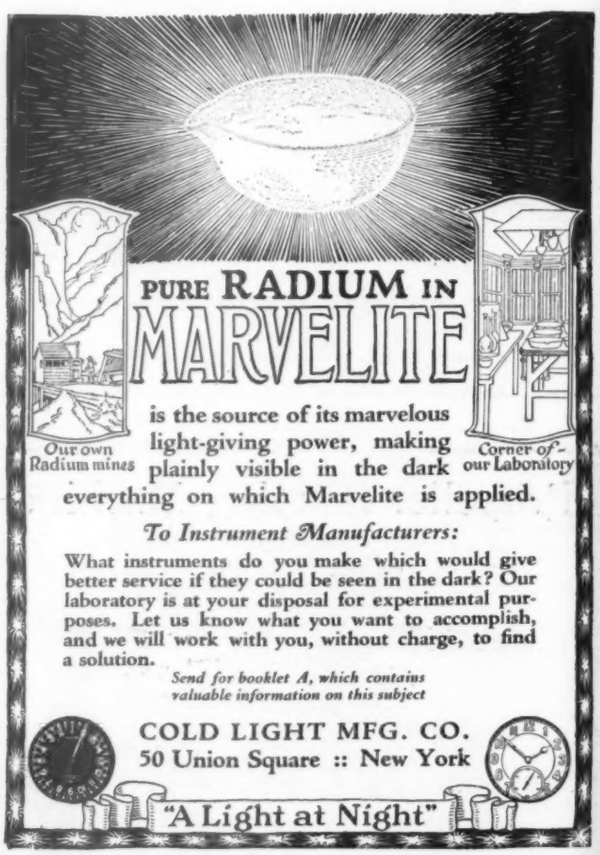
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By LIEUTENANT ALEXANDER KLEMIN

Aviation Section, Signal Corps, U. S. A., in charge of Aeronautical Research Department, Airplane Engineering Department. Until entering military service, in charge of Department of Aeronautics, Massachusetts Institute of Technology and Technical Editor of *Aviation and Aeronautical Engineering*

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Ajax Auto & Aero Sheet Metal Co. 533
Aluminum Brazing Solder Co. 589
Aluminum Co. of America. 584
American Bronze Corp. 541
American Propeller & Manufacturing Co. 590

B

Barcalo Mfg. Co. 579
Blum, Julius, & Co. 588
Boeing Airplane Co. 534
Boston Auto Gage Co. 586
Buffalo Pressed Steel Co. 583
Burgess Co., The. 535

C

Christensen Engineering Co. 582
Cold Light Manufacturing Co. 588
Curtiss Aeroplane & Motor Corp. 596

D

Dalton Manufacturing Corp. 587
Dayton-Wright Airplane Co. 538
Defiance Machine Works. 587
Doehler Die Casting Co. 591
Duesenberg Motors Corp. 546
Dunwoody Institute 584
Dupont American Industries. 593

E

Eagle Aviation School. 590
Ericsson Manufacturing Co. 577
Erie Specialty Co. 578

F

Fahrig Metal Co. 580
Flottorp Mfg. Co. 591
Foxboro, The, Co. 589
Fox Machine Co. 587

G

General Bakelite Co. 540
Goodyear Tire & Rubber Co. 543
Greb Company 584
Gurney Ball Bearing Co. 595

H

Hall-Scott Motor Car Co. 531
Hammacher, Schlemmer & Co. 578
Hardy, F. A., & Co. 577
Hartzell Walnut Propeller Co. 571
Hendee Manufacturing Co. 586

J

Jacuzzi Bros. 581
Johns-Manville, H. W., Co. 585

K

Kawneer Mfg. Co. 545
King Sewing Machine Co. 582

L

L. W. F. Engineering Co. 532
Lansing Stamping & Tool Co. 591

M

Martin, Glenn L., Co. 530
Mattison, C., Machine Works. 587
Moffat, Yard & Co. 590
Moto-Meter Co. 573
Motor-Compressor Co. 591

N

New Departure Mfg. Co. 548
New York Wire & Spring Co. 589

P

Palmer-Simpson Co. 590
Park Drop Forge Co. 576
Philips-Brinton Co. 589
Pratt & Lambert. 594

R

Radium Dial Co. 576
Radium Luminous Material Corp. 570
Roebling's, John A., Sons Co. 590
Rome-Turney Radiator Co. 586
Rubay Co. 589

S

Sherwin-Williams Co. 572
Sperry Gyroscope Co. 539
Standard Aircraft Corp. 536
Standard Turnbuckle Co. 580
Steel Products Co. 542
Stimpson, Edwin B., Co. 589
Stone Propeller Co. 590
Strauss & Buegeleisen. 591
Strong, Carlisle & Hammond Co. 544

T

Taylor Instrument Companies. 591
Terry, Herbert & Sons, Ltd. 588
Thomas-Morse Aircraft Corp. 575
Titeflex Metal Hose Corp. 585

U

Union Gas Engine Co. 536

V

Valentine & Co. 569
Veeder Mfg. Co. 584

W

Wakefield, C. C., & Co., Ltd. 581
Warner, Wm. Deshler. 591
West Woodworking Co. 586
Wisconsin Motor Manufacturing Co. 590
Witteman-Lewis Aircraft Co. 582
Wood, J. W., Elastic Web Co. 580
Wyman-Gordon Co. 547

Y

Yale & Towne Mfg. Co. 582
Yates, P. B., Machine Co. 580

Z

Zenith Carburetor Co. 590

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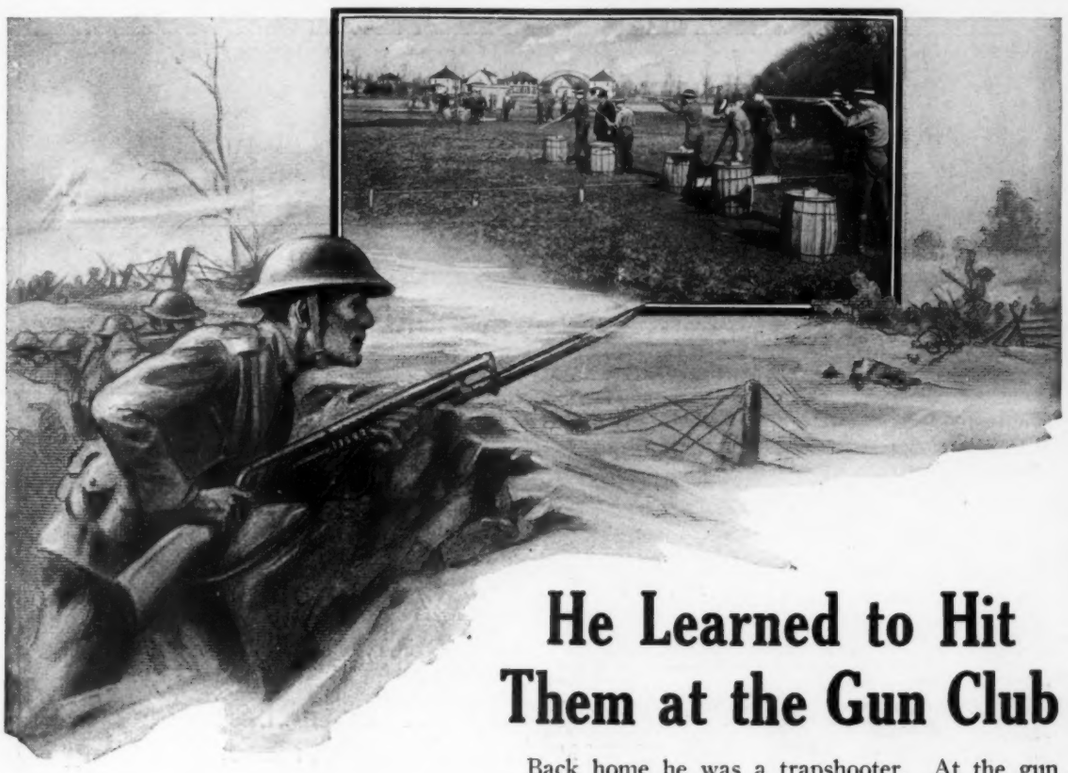

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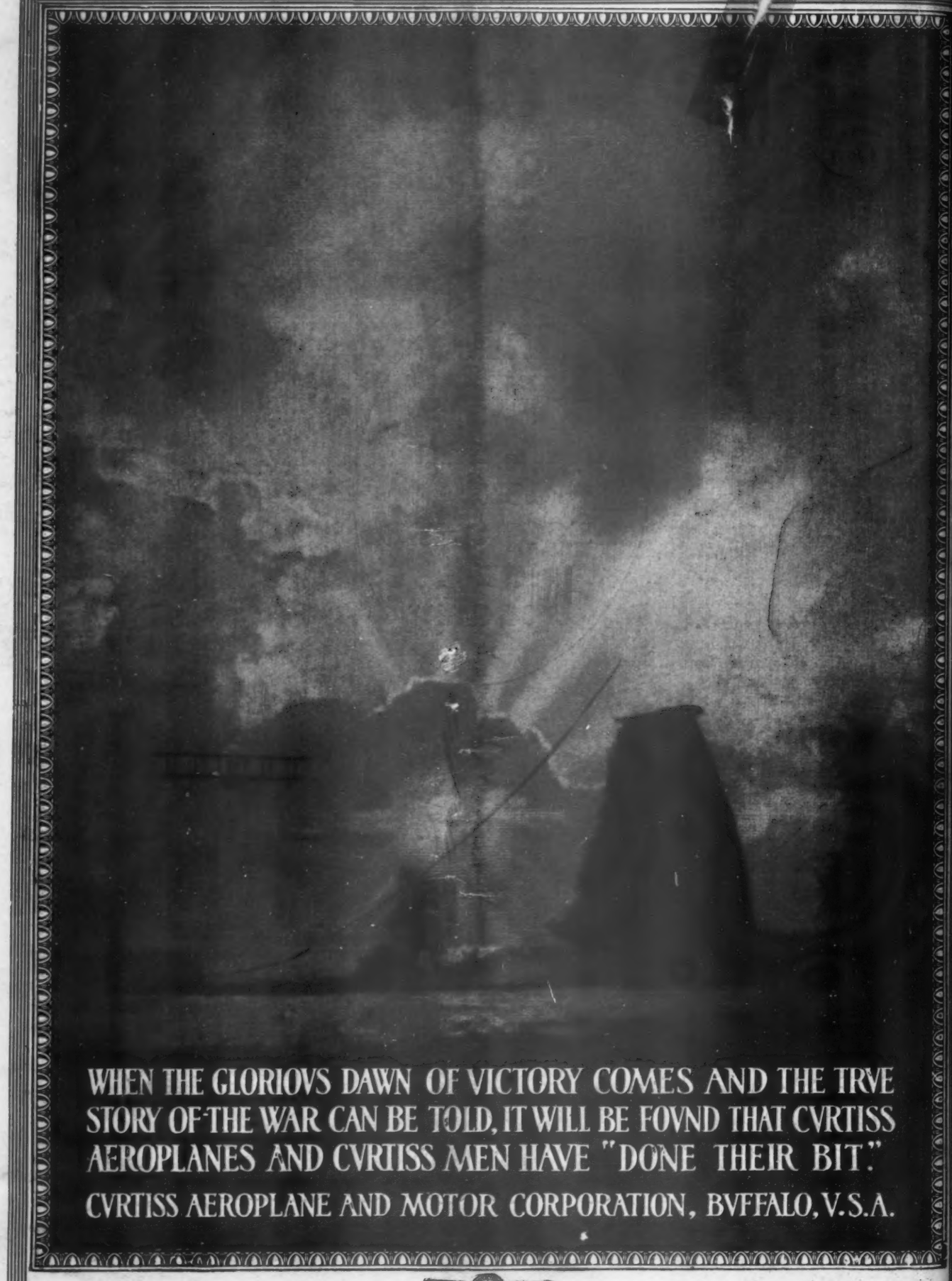

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